FINAL – REVISION 1

Corrective Measures Proposal
Institute Facility
Institute, West Virginia

Prepared for

Union Carbide Corporation

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ch2m

Executive Summary

Background

The corrective measures proposal (CMP) has been prepared for the Union Carbide Corporation (UCC) Institute Facility in Institute, West Virginia (hereafter referred to as the "facility") to present information necessary for the U.S. Environmental Protection Agency (USEPA) to approve the proposed corrective measures (CMs) and develop a Statement of Basis for public comment. The facility has a Resource Conservation and Recovery Act (RCRA) Corrective Action (CA) permit issued by USEPA.

The 433-acre facility consists of two distinct areas: the area containing the main chemical plant (historical and current operations, including production of hydrocarbon and agricultural products) and the area containing the facility's wastewater treatment unit (WWTU) (Figure ES-1). Heavy industrial chemical manufacturing processes currently dominate at the main chemical plant, with more than 95 percent of the approximate 350-acre plant area covered by buildings, gravel, asphalt, and/or concrete. Current and expected future land uses for both areas are industrial or commercial.

Twenty-three solid waste management units (SWMUs), four Areas of Concern (AOCs), and two newly designated "Corrective Measures Study (CMS) Areas" (Areas A and B) that are comprised of multiple, contiguous regions of investigation and/or CMs, are labeled on Figure ES-1 and described in Table ES-1. Numerous environmental investigations have been completed and reported at the facility since 1986 that document site conditions sufficiently for issuance of a Final Decision.

Subsurface Conditions and Hydrology

The facility is located along the banks of the Kanawha River on a narrow alluvial plain adjacent to a topographic bluff that bounds the Kanawha River Valley north of the facility. Natural subsurface materials are comprised of a sequence of river alluvium (interbedded gravel, sand, silt, and clay, 45 to 50 feet thick) overlain by surficial fill (human-made and natural materials, 0 to 10 feet thick) and underlain by bedrock (sandstone, shale, siltstone, limestone, and coal sequences). The thickness of the alluvium and fill thins north of the site.

Groundwater beneath the facility occurs in 1) zones that are limited in aerial extent and perched on top of low-permeability alluvium (depths ranging from approximately 7 to 13 feet below ground surface [bgs]); and 2) in an unconfined aquifer with a water table typically measured at depths of 15 to 20 feet bgs. Groundwater flow direction is southward toward the Kanawha River with localized variations due to variability in the permeability of the unconsolidated materials and/or the presence of buried utilities. Vertical groundwater gradients vary from a mainly neutral to a slightly upward gradient within the interior of the facility to a downward gradient near the Kanawha River. No potable water intakes are present at or near the facility.

Nature and Extent of Contamination

Soil impacts are generally localized and associated with individual SWMUs and AOCs. Constituents of concern (COCs) (constituents whose concentrations cause calculated risk values to exceed established risk thresholds) relevant to soil are the semivolatile organic compound (SVOC) naphthalene in the subsurface soil at the WWTU and in the surface and subsurface soil at SWMU 7, benzene in subsurface soil in CMS Area B, and lead in the subsurface soil at SWMU 13 (Figure ES-1).

The highest dissolved groundwater concentrations generally occur adjacent to source areas associated with historical chemical process activities, but concentrations only require active groundwater CMs in a few areas on the facility. Metals, volatile organic compounds (VOCs), and SVOCs are present in groundwater at concentrations greater than screening levels (USEPA Maximum Contaminant Levels [MCLs], USEPA Regional Screening Levels [RSLs] for tap water, and/or USEPA Vapor Intrusion (VI) Screening Levels [VISLs]) at various locations across the facility and at some portions of neighboring properties. Several plumes of dissolved VOCs and SVOCs in groundwater exceed their respective drinking water and/or VISLs relative to indoor air concentrations. However, there are no drinking water wells on or near the facility and annual evaluation of groundwater data (in accordance with the USEPA-approved sitewide groundwater monitoring program) indicates the VI pathway is insignificant for currently occupied site buildings.

Risk Assessment

A human health risk assessment (HHRA) and an ecological risk assessment (ERA) were both completed for the facility to support risk management requirements/decisions by identifying concentrations and areas/media where estimated risks exceed risk thresholds. Potential health impacts are evaluated according to two types of established risk thresholds — excess lifetime cancer risk estimates (ELCR - threshold of 1×10^{-4}) and non-cancer hazard indices (HIs - threshold of 1) — to assess the need for further action based on the assumption of non-residential land use for the facility. For the HHRA, risk estimates were organized in accordance with eight Exposure Units (EUs) that divide the facility to apportion environmental data according to geographical location, operational history, SWMU and AOC boundaries, existing CA areas, and soil sample locations, as shown in Figure ES-1. Those EUs or subareas within EUs with estimated risks above thresholds are summarized in Table ES-1.

Final Corrective Measures and Evaluation Criteria

CMs are proposed for portions of the facility with conditions that present estimated risks above established thresholds (Table ES-1). Completed interim measures are proposed as final CMs where appropriate. Institutional controls (ICs) and/or active remediation are utilized to manage estimated risks present at each EU. The ICs will be implemented using environmental covenants (ECs) or in accordance with requirements that will be outlined in a Materials Management Plan (MMP) that will be prepared as part of the Corrective Measures Implementation Plan (CMIP).

Final CMs selected were evaluated against USEPA's threshold criteria, including 1) ability to protect human health and the environment based on current and anticipated land use(s); 2) ability to meet cleanup objectives; and 3) ability to stop further environmental degradation. USEPA's balancing criteria were also used to assess CMs: 1) long-term reliability and effectiveness; 2) reduction of toxicity, mobility, or waste volume; 3) short-term effectiveness until objectives are achieved; 4) implementability of the technology; and 5) cost of the technology and its maintenance.

There are several measures already employed at the facility on a sitewide basis to address potential risk from dissolved groundwater contaminants. In addition to utilizing remedial objectives, site-specific performance standards were established to specifically address groundwater. The USEPA-approved sitewide groundwater monitoring program has been in place since 2011 and was updated with a revised program in 2014 to 1) determine if concentrations in impacted areas are stable or decreasing; 2) monitor the site perimeter; 3) document water quality improvement; 4) detect and respond to changes in site conditions; and 5) identify areas where additional active remediation may be necessary. The sitewide program is described in the approved *Sitewide Groundwater Performance Monitoring Plan* (CH2M 2011d), and groundwater data are reported annually.

Neighboring Properties

Groundwater concentrations from the Institute Facility have impacted portions of several neighboring properties, including the southern portion of the Appalachian Power Company (APCO) substation, the southwestern portion of West Virginia State University (WVSU), the eastern portion of Private Trucking Operations (PTO), and likely the portion of Norfolk Southern (NS) that traverses the facility's main chemical plant area and WWTU. An EC is proposed for each of these properties due to the groundwater concentrations that exceed screening levels as a result of groundwater migration from the Institute Facility. An EC that prohibits groundwater extraction except for remediation purposes or to support electrical substation construction is proposed for the APCO property. An EC is also proposed for the southwest corner of the WVSU property that prohibits the construction of occupied structures over areas of identified VI risk, unless a VI mitigation is completed, and that restricts groundwater extraction except for remediation purposes or to support subsurface construction.

Although there are no groundwater sampling results specifically collected from the NS property that traverses through the Institute Facility property, an EC is also proposed for NS to address expected groundwater concentrations based on adjacent Institute Facility conditions. An EC is proposed to prohibit the construction of occupied structures over NS unless a VI mitigation system is installed, and to restrict groundwater extraction except for remediation purposes or to support subsurface construction.

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Table ES-1. Exposure Unit, Solid Waste Management Unit, Area of Concern, and Corrective Measure Study Area Summary
Union Carbide Corporation Institute Facility
Institute, West Virginia

			Final Corrective Measure(s)						
			Institutional Controls						
	Description of Solid Waste Management Unit (SWMU), Area of Concern (AOC), or Corrective Measures Study (CMS) Area	**Direct Contact Restrictions Due to Exceedance of Established Risk Thresholds(s)[a] and/or Subsurface Waste in Place**	**Industrial/Commercial Land Use Restriction**	**VI Restriction for New Building Construction (exposure to groundwater vapors)**	**Groundwater Use Restriction (no drinking or irrigation uses allowed)**	**Prohibit Offsite Soil Movement**	**Surface Soil Restriction (direct contact with surface soil 0 - 2 feet below ground surface)**	**Subsurface Earthwork Restriction (direct contact with subsurface soil at depths >2 feet)**	**Additional Corrective Measures**
EU-1		• Subsurface soil – direct contact restriction applied across Exposure Unit (EU)-1 due to subsurface risk estimates above thresholds.	X	X	X	X		X	
SWMU 11	• Former Chemfix area (~6 acres) was used for sludge disposal from the water treatment plant. • Most sludge was "fixed" into a solid form with the addition of kiln dust, cement, and/or other material, and the area was then capped. • Buried waste remains in place; waste is capped with a soil cover.	• Surface soil – direct contact restriction applied for Solid Waste Management Unit (SWMU) 11 to mitigate cover disturbance. • Subsurface soil – direct contact restriction applied for SWMU 11 due to waste-in-place.					X		• Engineered soil cover already in place over SWMU 11. • SWMU-11 will be managed in accordance with ICs appropriate for a former landfill.
Closed RCRA Ponds	• Six Resource Conservation and Recovery Act (RCRA)-closed ponds and three non-RCRA-closed ponds formerly associated with the wastewater treatment unit (WWTU), all in post-closure care. • WWTU and the closed RCRA ponds and biobasins are managed under an RCRA Part B Operating Permit issued by the West Virginia Department of Environmental Protection (WVDEP) in 2008 and amended March 2014 to include a corrective action (CA) module; to be incorporated into WVDEP RCRA CA Permit once issued following Final Decision. • Both the RCRA- and non-RCRA-closed ponds at the WWTU are in post-closure care.								• Abandonment of existing groundwater recovery wells near former Biobasins 1 and 2.
EU-2			X			X			
SWMU 19	• Former "Westside Landfill" (~1977 to 1992) used for storage of demolition wastes, including metal equipment, plastic items, and soil piles. • Approximately 24 acres were fenced in the early 1990s to eliminate further storage; materials have been removed. • Currently an open area overgrown with vegetation. • Soil and groundwater concentrations are below industrial/ commercial risk-based screening levels (RBSLs) or within the range of background concentrations.								• No additional actions required.
EU-3			X	X	X	X			
SWMU 12	• Wash pad north of ethylidene norbornene Unit								• NFA.
CMS Area A									• Aerobic Co-Metabolic Bioremediation (ACB) via Co-Metabolite-

									Enhanced Biosparging.
SWMU 18	• Former loading station where fluorocarbons were transferred from an overhead pipe rack to containers or trucks (demolished). • Soil concentrations are below industrial/commercial RBSLs.								• Post-shutdown groundwater monitoring to determine concentration trends; if statistically significant increasing concentrations of constituents of concern (COCs) are observed, indicating a continuing source present in the vadose zone, an evaluation will be conducted to determine the feasibility and effectiveness of implementing a targeted soil remedy in order to meet the site-specific remedial action objective (RAO).
SWMU 22	• Former loading and unloading station from chemical transfer lines to tank trucks. • Soil concentrations are below industrial/commercial RBSLs.								
Former Fluorocarbon Area	• Former fluorocarbon production unit (1958 to 1978) where carbon tetrachloride, chloroform, and tetrachloroethene (PCE) were used as raw chemicals; final products included trichlorofluoromethane (TCFM) and dichlorodifluoromethane (DCFM). • Production process generated waste hydrochloric acid that contained residual fluorocarbons, PCE, chloroform, and/or carbon tetrachloride. • Soil concentrations are below industrial/commercial RBSLs.								
AOC 3	• Building 111 Blasting Grit.								• NFA
EU-4			X	X	X	X			
SWMU 5	• Former fly ash landfill where the majority of waste has been removed. • Soil concentrations do not exceed industrial/commercial RBSLs.								• No additional actions required.
SWMU 8	• Methanol Storage Tank 1518 / Glycol Unit.								• NFA.
SWMU 10	• Byproduct Fuels Tank 1885 – LARVIN® Unit.								• NFA.
AOC 4	• The LARVIN® structure located south of Building 178.								• NFA.
EU-5			X	X	X	X			
SWMUs 2 and 6	• Waste remains in place within this "No. 2 Ash Pond" built on top of a section of the 4-acre "No. 2 Fly Ash Landfill." • A minimum 6-inch clay cap (laboratory permeability = approximately 3- to 4 x 10^{-8} centimeters per second) covered with soil and established vegetation. • The pond provides solids separation for coal ash fines prior to discharge to a National Pollutant Discharge Elimination System (NPDES) outfall. • Landfill materials include cinders, coal, glass, and black organic oil, and sludge mixed with ordinary gravel and sand.	• Surface soil direct contact restriction applied for SWMUs 2 and 6 to mitigate cover disturbance. • Subsurface soil – direct contact restriction applied for SWMUs 2 and 6 due to waste-in-place.					X	X	• The SWMU will be managed in accordance with institutional controls (ICs) appropriate for a former landfill. • The pond is currently being closed as part of the facility ownership change; the residual material is being removed from the pond and disposed offsite; the pond will be backfilled with native material (from the walls) and additional fill to be consistent with the landfill cover.
SWMU 4	• Formerly a landfill where toluene diisocyanate (TDI), toluene diamine, and other unit wastes may have been disposed. • Waste materials are believed to have been removed prior to construction of the synthetic gas unit (that has since been demolished). • Soil concentrations are below risk thresholds.								• No additional actions required.
SWMU 16	• Chemical Cleaning Building (#334) actively being used for miscellaneous cleaning operations using solvents and chlorinated solvents. • Soil concentrations are below risk thresholds.								• No additional actions required.
SWMU 17	• Gravel area that had been used for burning flammable residues from metal parts and other materials. • Soil concentrations are below risk thresholds.								• No additional actions required.
EU-6			X	X	X	X			
SWMU 9	• Residue Aluminum Storage Tanks 1037 & 1038 / Naphthol and Acetone (26,000 gallons each) that sat on a gravel area and were removed in 1990. • Soil concentrations are below risk thresholds.								• No additional actions required.
SWMU 14	• Tank Station 106/Plant Laboratory.								• NFA.
SWMU 23	• Ethylene Oxide/BEHP Loading Rack.								• NFA.

CMS Area B		• Subsurface soil – direct contact restriction applied across Corrective Measure Study (CMS) Area B due to risks above thresholds (except under the Norfolk Southern mainline railroad tracks right-of-way where there were no operations)						X	
Tank 1010 Area (Included in CMS Area B)	• A 1.47-million-gallon aboveground storage tank (AST) currently used to store anti-freeze-grade ethylene glycol (since 1981); previously stored benzene (1943 to 1981) associated with the former styrene production units. • Includes former rail unloading area north of the AST that included a former pipe trench. • In situ chemical oxidation (ISCO) injections were completed in the former rail unloading area in 2014 and 2015 to address benzene concentrations in source area soils and groundwater; results indicate an overall reduction in benzene concentrations in groundwater but limited effectiveness for soil impacts. • Soil concentrations exceed risk thresholds; however, technically impracticable to address due to existing infrastructure.								• No active remedy at this time due to technical impracticability; however, if future operating conditions change and Tank 1010 is no longer utilized as part of an active chemical unit, then additional evaluation will be completed to determine if remediation remains technically impracticable or if remediation may be implemented to permanently remove or remediate benzene-impacted soils.
High Purity Hydrocarbon (HPH) Area (Included in CMS Area B)	• Four 10,000-gallon ASTs formerly used to store high-purity hydrocarbon (HPH) fuel oil, process residue waste, and other constituents. • Air sparge/soil vapor extraction (AS/SVE) activated in 2011 to address benzene, toluene, ethylbenzene, xylenes, and naphthalene in shallow soils and groundwater.								• Continued operation of the AS/SVE until the RAOs and the remedial operational goals are met as evidenced by monitoring results.
EU-7			X	X	X	X			
SWMU 1	• Former 1-acre UCAR landfill, originally occupied by the toluene diisocyanate (TDI) unit. • Oil, tarry materials, and possibly soluble hydrocarbons from a gas cracking unit disposed of here in the 1940s and 1950s; now a gravel-covered, level area crossed by a rail line. • Waste remains in place, with "seeps" of a black, tar-like substance that historically surface. • Interim removal of the tar-like substance has been completed over time starting in 2003.	• Surface soil direct contact restriction applied across SWMU 1 to mitigate cover disturbance. • Subsurface soil direct contact restriction applied across SWMU 1 due to subsurface waste-in-place material.					X	X	• The SWMU will be managed in accordance with ICs appropriate for a former landfill. • Continued, focused removal of tar-like substances (hot-spot excavation and removal, and/or covering of with offsite disposal at an approved waste disposal facility; backfilling with clean material). • Installation of permanent fencing and improvement of existing signage.
SWMU 3	• Past Landfill/Coal Pile.								• NFA.
SWMU 7 (includes SEVIN® and NCF Areas)	• Former SEVIN® production unit (demolished in 2013). • Interim remedy (AS/SVE) completed in 2002 after reduction of more than 99 percent of the toluene concentration. • Soil concentrations in the southwest corner of SWMU 7 are above risk thresholds.	• Surface and subsurface soil risk thresholds exceeded, but Corrective Measure hot-spot removal planned.					**	**	• Removal of an area of surface and subsurface naphthalene concentrations from the southwest corner that exceed industrial/commercial RBSLs. • Document sampling results, delineation efforts, and excavation in a construction completion report.
SWMU 20	• Former Southside Loading Rack for the SEVIN® Unit (demolished in 2013). • The Southside Loading Rack (SWMU 20) was composed of a 20-foot by 40-foot asphalt-covered concrete and/or asphalt residue transfer station for tank trucks, and was demolished in 2013. • Soil concentrations are below risk thresholds.								• No additional actions required.
SWMU 21	• Polyols Tank Car Rack.								• NFA.
AOC 1	• Construction Blasting Grit Area.								• NFA.
AOC 2	• Former naphthalene tank demolished in 1995. • Gravel in the area beneath former tank contained solidified naphthalene and staining. • Approximately 290 cubic yards of soil and gravel were excavated and removed. • Soil concentrations are below risk thresholds.								• No additional actions required.

EU-8			X	X	X	X			
SWMU 13	• 10,000-gallon hydroxyethyl cellulose (HEC) storage tank adjacent to former Building 87, which rested on a concrete foundation and was surrounded by a concrete dike. • Tank was demolished and area is now covered with gravel and concrete. • Lead concentrations in subsurface soil samples from northeast corner of SWMU 13 exceed the USEPA Regional Screening Level (RSL) for Industrial Soil.	• Subsurface soil – direct contact restriction applied across SWMU 13 due to risks above thresholds.						X	• No additional actions required.
SWMU 15	• Eastside Tank Car/Truck Cleaning Rack - solvent materials were manufactured and shipped in the area. • Tank car cleaning area consists of four parallel sections of railroad track through a gravel-covered area. • Tank car cleaning is currently in service and is completed on an asphalt pad immediately west of the railroad tracks. • Soil concentrations are below risk thresholds.								• No additional actions required.

Grey shading indicates the SWMU was screened out from further action prior to the Corrective Measures Proposal (CMP).

[a] Established risk thresholds based on continued non-residential land use, an excess lifetime cancer risk greater than 1 x 10^{-4}, or a hazard index greater than 1.

X = This IC will be applied to the relevant EU, AOC, or SWMU.

** = No restrictions required, because corrective action for hot-spot removal is planned.

Figure

ES-1 Facility Exposure Units

Contents

Section Page

Figures

Acronyms and Abbreviations

µg/L	micrograms per liter
ACB	aerobic co-metabolic bioremediation
AOC	Area of Concern
APCO	Appalachian Power Company
AS	air sparge
AST	aboveground storage tank
bgs	below ground surface
CA	Corrective Action
CAO	corrective action objective
CMIP	Corrective Measures Implementation Plan
CCR	*Current Conditions Report*
cm/s	centimeters per second
CMP	corrective measures proposal
CMS	corrective measures study
COC	constituent of concern
COPC	constituent of potential concern
CSEM	conceptual site exposure model
DCFM	dichlorodifluoromethane
DPT	direct-push technology
DTI	Deep Earth Technologies, Inc.
Dow	The Dow Chemical Company
EC	environmental covenant
ELCR	excess lifetime carcinogenic risks
ENB	ethylidene norbornene
ERA	ecological risk assessment
EU	Exposure Unit
facility	Union Carbide Corporation Institute Facility in Institute, West Virginia
GWSL	groundwater screening level
HASP	Health and Safety Plan
HHRA	human health risk assessment
HI	hazard index
HPH	high-purity hydrocarbons
HQ	hazard quotient

IC	institutional control
ISCO	in situ chemical oxidation
mg/kg	milligram per kilogram
mg/L	milligrams per liter
MCL	maximum contaminant level
MMP	Materials Management Plan
NFA	No Further Action
NS	Norfolk Southern
O&M	operations and maintenance
PCE	tetrachloroethene
PMP	Performance Monitoring Plan
PTO	Private Trucking Operations
PVC	polyvinyl chloride
RA	remedial action
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RFI	Resource Conservation and Recovery Act facility investigation
RSL	regional screening level
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCFM	trichlorofluoromethane
TDI	toluene diisocyanate
TTZ	target treatment zone
UCC	Union Carbide Corporation
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VI	vapor intrusion
VISL	vapor intrusion screening level
VOC	volatile organic compound
WV 25	West Virginia State Route 25
WVDEP	West Virginia Department of Environmental Protection
WVSU	West Virginia State University
WWTU	wastewater treatment unit

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1 Introduction

This corrective measures proposal (CMP) has been prepared for the Union Carbide Corporation (UCC) Institute Facility in Institute, West Virginia (hereafter referred to as the "facility") (Figure 1-1) to present information necessary for the U.S. Environmental Protection Agency (USEPA) to approve the proposed corrective measures and develop a Statement of Basis for public comment.

The 433-acre facility is an industrial park located between the Kanawha River to the south, West Virginia State Route 25 (WV 25) to the north, UCC Private Trucking Operations (PTO) to the west, and West Virginia State University (WVSU) to the east (Figure 1-1). The facility began operations in 1943 during World War II as a synthetic rubber production plant and was owned by the federal government. UCC purchased and operated the facility from 1947 until 1986. Rhone-Poulenc, which became Aventis CropScience in January 2000, purchased the facility in 1986. Aventis CropScience subsequently became Bayer CropScience in 2002. The facility was repurchased by UCC in 2015.

The facility consists of two distinct areas: the area containing the main chemical plant and the area containing the wastewater treatment unit (WWTU). These areas are separated by approximately 0.5 mile of intervening properties that include an Appalachian Power Company (APCO) transformer substation, aggregate dock, and undeveloped land owned by UCC and containing Solid Waste Management Unit (SWMU) 19 (which was not defined as part of the facility on the original Part A Application, but is addressed within this CMP). The main chemical plant, which historically produced various hydrocarbon and agricultural products, currently produces products for agricultural use as well as those used in consumer goods.

The facility has a Resource Conservation and Recovery Act (RCRA) Corrective Action (CA) permit issued by USEPA. USEPA Region 3 initiated an RCRA CA permitting action on or about November 1984 to identify and remediate onsite SWMUs. This CA permit was issued by USEPA in December 1990, effective January 22, 1991, to January 21, 2001, and was subsequently extended. The permit identified 18 SWMUs, and five additional SWMUs were identified by the facility and included in the Verification Investigation Work Plan (REMCOR 1992). USEPA is the lead agency for implementing the RCRA CA permit. The West Virginia Department of Environmental Protection (WVDEP) and USEPA agreed in 2011 that CA measures for the WWTU would be addressed by the RCRA CA permit issued for the main chemical plant (USEPA 2011).

Numerous environmental investigations and reports have been completed at the facility, the majority of which are summarized on Table 1-1. Based on the results from various site investigations, UCC has completed interim measures at the facility and is proposing those as final corrective measures as part of this CMP.

1.1 Purpose and Objectives

This CMP presents the supporting information necessary for USEPA to make Corrective Action Complete decisions for the facility and prepare the Statement of Basis. The overall objectives for corrective measures at the facility are to protect human health and the environment during current operations, while allowing the property to be put into future beneficial use. Specific objectives for the facility comprise the following:

1. Protect human health and the environment from current and future potentially unacceptable risks due to releases of hazardous constituents at or from the facility.
2. Implement corrective measures for portions of the facility that present risks above thresholds. Risk thresholds are calculated concentrations for individual media that, if exceeded, may indicate the need for further action. USEPA's risk management range is $1\text{x}10^{-6}$ to $1\text{x}10^{-4}$ (1 in 1 million to 1 in

10,000) for cancer risk. Non-cancer hazard indices (HIs) are also determined using concentration data for an individual media; non-cancer HIs are evaluated against the threshold of 1 (USEPA 1989, 1991).

3. Continue to work proactively with USEPA and WVDEP for all aspects of corrective measures for the facility.

1.2 Report Organization

This CMP is organized as follows:

- Section 1 provides the introduction to the CMP.
- Section 2 provides a summary of the facility background, relying on other documents, including the *Final Current Conditions Report* (CCR; CH2M 2009a) previously submitted to USEPA and WVDEP or included as appendices in this CMP.
- Section 3 identifies and presents details for each proposed final corrective measure to address exposures to impacted media, under current and future land use, which have the potential to result in risks above thresholds.
- Section 4 provides a schedule for implementing the proposed final corrective measures for the facility.
- Section 5 lists references cited in the CMP.

The appendices included with this CMP are the following:

- Appendix A, presented on the accompanying CD, contains nine additional reports appended to report data, data evaluation, corrective measures evaluation, and/or corrective measures implementation, for various portions of the facility that were not previously submitted.
- Appendix B, also presented on the accompanying CD, contains the summary statistics tables completed in support of risk evaluation for groundwater.

2 Project Background

This section provides information on the layout of the facility, the characteristics of the subsurface, a generalized description of the nature and extent of contamination at the property, current and future land use, and a summary of human health and ecological risk assessments.

The Institute facility (Figure 1-1) is separated into two distinct areas: the main chemical plant and the WWTU. SWMU 19, historically referred to as the "Westside Landfill," is located outside the facility boundaries between the two areas. The identified SWMUs and Areas of Concern (AOCs) at both parts of the facility are numbered and named on Table 2-1 along with a short description of the current status of each. Many of the SWMUs and AOCs have been previously investigated and historically determined to require no further action; therefore, evaluation of corrective measures is not included in this CMP for those SWMUs and AOCs that have No Further Action (NFA) status.

2.1 Main Chemical Plant

The facility operational history for the main chemical plant area is included in Section 1. The site location of each SWMU and AOC situated in the main chemical plant area is provided on Figure 2-1, along with the locations of additional subareas that were also historically operational and/or that received interim remedial actions (RAs), but that had not been specifically named as SWMUs or AOCs during initial RCRA assignments. Descriptions of chemical handling activities relative to individual SWMUs are described in Section 3.

For the purposes of discussing planned, future corrective measures for the main plant area in this CMP, some of the contiguous SWMUs/areas that have similar characteristics (contaminants, physical features, other) are combined into corrective measures study (CMS) areas as delineated on Figure 2-1. The CMS areas shown on Figure 2-1 are comprised of the following subareas:

- CMS Area A includes SWMU 18, SWMU 22, the former fluorocarbon production unit, and the three former ethylidene norbornene (ENB) areas (north, central, and south). This zone is a contiguous area containing multiple SWMUs/areas that will be dealt with similarly during long-term operations.
- CMS Area B includes the High-Purity Hydrocarbons (HPH) Area and Tank 1010 Area due to their close proximity and the presence of benzene in soil and groundwater at both areas.

2.2 WWTU

The WWTU, which was constructed in the early 1960s to receive and treat process water generated at the main chemical plant, currently treats liquids from the Institute main chemical plant and PTO facilities. The WWTU is composed of current operating facilities, former operational ponds, and one SWMU described as follows (CH2M 2015a):

- The active WWTU buildings and infrastructure;
- Six former ponds, basins, and biobasins that are closed RCRA units;
- Three additional former ponds that were not RCRA regulated and are closed; and
- SWMU 11, also known as the closed Chemfix landfill (originally identified as the WWTU Holding Pond).

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2.3 Neighboring Properties

APCO owns a parcel of property situated along the north side of the Kanawha River between UCC's main chemical plant and the WWTU, as shown on Figure 1-1. WVSU owns the property situated along the north side of the Kanawha River adjacent to the UCC main chemical plant to the east, as shown on Figure 1-1. Several residential properties not owned by WVSU, but located within the approximate WVSU property boundary, are situated east of the main chemical plant area, although the properties do not directly border the Institute facility. Norfolk Southern (NS) operates an active railway that runs through the main chemical plant and the WWTU.

2.4 Subsurface Characteristics

The physical and environmental conditions have been well characterized by investigations performed across the facility and in the region. Detailed information regarding conditions at the facility is provided in the CCR (CH2M 2009a). The facility is located along a narrow alluvial plain (approximately 1,200 to 3,500 feet wide) along the banks of the Kanawha River. A steep bluff approximately 30 feet high is present along the north side of the river (north of the facility) that transitions to a generally flat plain with a gentle slope toward the river. Beyond the northern facility boundary, the topography rises several hundred feet up into an area of hills north of the Kanawha River Valley.

2.4.1 Geology

A detailed summary of subsurface conditions was defined in the CCR (CH2M 2009a). A generalized depiction of subsurface conditions is indicated on Figure 2-2. Conditions at the facility are typical for this physiographic setting, consisting of a sequence of unconsolidated deposits comprised of surficial fill (human-made and natural materials, 0 to 10 feet thick) and alluvium (45 to 50 feet thick) associated with the ancestral Kanawha River. The total thickness of unconsolidated material above the bedrock ranges from approximately 45 to 60 feet. Alluvium deposits consist primarily of interbedded gravel, sand, silt, and clay. Coarse gravels are found along the alluvium/bedrock interface, sandy material predominates at intermediate depths, and fine-grained silt and clay predominate in the upper portion of the alluvium/fill. A relatively thick stratum of clay and silt is present at the surface along the riverbank. The thickness of the unconsolidated material thins dramatically away from the Kanawha (northward) as bedrock rises up to the mountainous region. The uppermost bedrock is comprised of the Conemaugh series ranging from 500 to 600 feet thick and consisting of a variety of lithologic types, including sandstone, shale, siltstone, limestone, and coal.

2.4.2 Hydrogeology and Hydrology

The hydrogeologic system is strongly influenced by the physical conditions at the facility. Groundwater at the facility is found under two different conditions, or zones. The first consists of perched zones locally encountered on top of low-permeability alluvium. The perched zones are limited in aerial extent and occur at depths ranging from approximately 7 to 13 feet below ground surface (bgs). The second type of zone consists of an unconfined aquifer with a water table typically measured at depths of 15 to 20 feet bgs. Groundwater in the aquifer is primarily recharged by precipitation with a limited amount of recharge from upstream/upgradient alluvium and from bedrock in upland areas adjacent to the facility.

Groundwater flow direction is generally toward the Kanawha River (Figure 2-3), which is normally a gaining stream, although temporary flow reversals may occur with surface water recharging groundwater for short periods during flood events. Variability in the permeability of the interbedded clay, silt, sand, and gravel units may result in localized variations in flow direction as evidenced in the southeast quadrant of the facility where there is a localized southeasterly flow component (Figure 2-3). Manufactured structures, such as buried sewer lines, also affect localized groundwater flow direction, although their influence is not well understood or mapped. Vertical hydraulic gradients vary from a mainly neutral to a slightly upward gradient within the interior of the facility to a downward gradient near the Kanawha River (CH2M 2012c).

Streams in the vicinity of the facility include Ryan's Branch, Washington Branch, and Goff's Branch (Figure 1-1). Ryan's Branch is located southwest of the WWTU, and Washington Branch lies along the eastern boundary of the facility. Goff's Branch flows from west to east, paralleling the southern flank of SWMUs 2 and 6 (Figures 1-1 and 2-1). The Kanawha River is a relatively large, freshwater body, located adjacent to the southern boundary of the facility with an average flow in 2008 of 13,760 cubic feet per second (U.S. Geological Survey [USGS] 2009). The facility is located adjacent to the north side of the Kanawha River between the Winfield and Marmet dams (U.S. Army Corps of Engineers [USACE] 2004). The river level in this area of the Kanawha is controlled by the Marmet Dam, located approximately 18 miles upgradient of the facility; the river's mean stage is 566 feet above mean sea level.

There are "no records of potable water wells" within 0.25 mile of the facility (Kanawha-Charleston Health Department 2016). No potable water intakes are present at or near the facility (CH2M 2016a). Potable water for the cities of Charleston, South Charleston, Dunbar, Nitro, and Institute is provided by West Virginia-American Water Company via a surface water intake on the Elk River, which has its confluence with the Kanawha River upstream and north of the facility. Groundwater beneath the facility is not used for potable or industrial uses.

2.5 Nature and Extent of Contamination

2.5.1 Soil

More than 95 percent of the main chemical plant is covered by buildings, gravel, asphalt, and gravel/concrete with very little grass or exposed soil. Soil impacts are generally localized and associated with individual SWMUs and AOCs. Constituents of concern (COCs) relevant to soil (constituents whose concentrations cause calculated risk values to exceed risk thresholds) are the semivolatile organic compound (SVOC) naphthalene in the subsurface soil at the WWTU and in the surface and subsurface soil at SWMU 7, benzene in subsurface soils in CMS Area B, and lead in the subsurface soil at SWMU 13.

2.5.2 Groundwater

In general, dissolved groundwater concentrations resulting from historical facility activities where various chemicals were used are present on portions of the facility. The highest dissolved groundwater concentrations generally occur adjacent to source areas associated with historical chemical process activities, but concentrations only require active groundwater CMs in a few areas on the facility. Metals, volatile organic compounds (VOCs), and SVOCs are present in groundwater at concentrations greater than screening levels (USEPA Maximum Contaminant Levels [MCLs], USEPA Regional Screening Levels [RSLs] for tap water, and/or USEPA Vapor Intrusion Screening Levels [VISLs]) at various locations across the facility. Several source areas have received interim remedial measures at the facility to address elevated groundwater concentrations, including the Former Fluorocarbon Area (currently referred to as "Area 3") for chloroform, carbon tetrachloride, tetrachloroethene (PCE), and trichlorofluoromethane, and the HPH and Tank 1010 areas in CMS Area B for benzene (Figure 2-1).

Summary statistics for groundwater monitoring well data (representing the four most recent samples collected at each location [where available]) are included in Appendix B (presented on the CD accompanying this report); detected analytes are included and concentrations are compared to the following applicable screening levels:

- Maximum Contaminant Levels (MCL; USEPA 2015a);
- USEPA Regional Screening Levels (RSL) for tap water use (USEPA 2015a); and

- USEPA Vapor Intrusion Screening Levels (VISLs; USEPA 2015b), based on a commercial/industrial exposure scenario, a target cancer risk equal to 1×10^{-5}, a non-cancer hazard quotient (HQ) equal to 1, and a site-specific, average groundwater temperature equal to 19 degrees Celsius.

The statistical summary was completed for eight "Exposure Units" (EUs 1 through 8) at the facility and for the neighboring APCO and WVSU properties. The EUs were established across the facility using geographical location, operational history, SWMU and AOC boundaries, existing CA areas, and soil sample locations, as shown on Figure 2-4. Ratios calculating the maximum detected concentration to applicable screening levels (Appendix B) demonstrate that metals, VOCs, and SVOCs are present in groundwater at concentrations greater than MCLs, tap water RSLs, and/or VISLs at the facility and on both the APCO and WVSU properties. Ratios greater than 100 are suggestive of potential COCs because risk thresholds are commonly 100 times greater than generic screening levels (e.g., the difference between the 1×10^{-6} excess lifetime carcinogenic risk [ELCR] target used for screening and the 1×10^{-4} threshold). Ratios greater than 100 are present at the facility, except at EU-2 (SWMU 19, where only arsenic, which is attributable to background, meets this criterion), and on the WVSU property. Ratios greater than 100 were not reported for the APCO property. Further detailed discussion of groundwater concentrations compared to screening levels representing an unrestricted use (i.e., use as residential tap water) scenario is presented for each EU and for the neighboring properties in Sections 3.5 through 3.13 below.

Groundwater containing COC concentrations that exceed screening levels is likely present beneath the NS property that traverses through the main chemical plant (Figure 2-4), although groundwater samples have not specifically been collected from NS property. Groundwater containing COC concentrations greater than screening levels has also migrated west of the WWTU area towards the UCC PTO site. Low levels of site COCs were detected in groundwater samples collected at the offsite areas and were evaluated as discussed in Section 3.

2.5.3 Surface Water

Pore water samples were collected from the Kanawha River adjacent to the facility in 2009 and 2012 to evaluate whether COCs, including benzene, are discharging from groundwater to surface water. The pore water results indicated that site COCs are below established screening levels for the Kanawha River, with the exception of toluene at one location adjacent to the HPH area (CH2M 2013a).

2.6 Current and Future Land Use

Current and expected future land uses for the main chemical plant and the WWTU parcels are industrial or commercial. There are no official zoning requirements established for unincorporated areas of Kanawha County (Kanawha County Commission 2015).

Heavy industrial chemical manufacturing processes currently dominate at the main chemical plant, and future land use is also planned as industrial. More than 95 percent of the approximately 350-acre area of the main chemical plant is covered by buildings, gravel, asphalt, and/or concrete. Those areas not covered by structures or gravel/paved surfaces are covered with lawns that are periodically mowed. Chain-link or barbed-wire fence surrounds areas of the facility where there is industrial activity. The facility border that abuts the Kanawha River consists of steep slopes covered by riprap and restricted by fences.

The existing structures and buildings associated with the current WWTU activities are shown on Figure 2-1. Closed ponds are also present as previously described. The current and foreseeable future land use for this parcel is for continued WWTU operations (industrial). Closed ponds will be maintained as they are at present, including mowing and periodic inspection.

SWMU 19, located between the main chemical plant and WWTU areas, is overgrown with vegetation; land use is currently undeveloped and "natural," and the potential future use of this area is expected to remain unchanged although commercial/industrial re-use may occur.

2.7 Human Health Risk Assessment

Human health risk assessments (HHRAs) are comprised of five basic components that, when summarized as a whole, can be used to support risk management requirements: 1) analytical data; 2) exposure pathways; 3) toxicity; 4) risk characterization; and 5) uncertainties. Summarized in this section are the conceptual site exposure model (CSEM) of potentially complete exposure pathways for the Institute facility and the results of the risk characterization. The applicable analytical data, exposure assumptions, and toxicity criteria for the analytes are used together to characterize risk. The methods, assumptions, and results for the facility are provided in the following associated HHRA reports:

- *Screening-Level Human Health Risk Assessment for Soil and Shallow Groundwater* (CH2M 2016a);
- *Groundwater to Surface Water Screening Levels and Risk Evaluation* (CH2M 2012a);
- *Groundwater to Surface Water and Sediment Risk Evaluation for Metals* (CH2M 2014a); and
- Associated reports evaluating the vapor intrusion (VI) pathway (CH2M 2011a, 2014b, and 2016b).

The CSEM is an overview of site conditions, potential constituent migration pathways, and exposure pathways to potential receptors. The associated buildings at the facility are used for storage, office space, or other industrial operations. Future land use at the facility is anticipated to remain industrial/ commercial. A significant amount of building demolition and construction to accommodate future use has already occurred at the facility, and more will likely take place in the future. Overall, potentially complete pathways identified during the various studies and reports include the following:

- **Current and Future Commercial/Industrial Workers:** Industrial workers could be exposed to surface soil (0 to 2 feet bgs) during maintenance or other work activities at the site or subsurface soil (0 to 12 feet bgs) following construction activities after subsurface soil is brought to the surface and mixed with surface soil. Potential routes of exposure to soil include incidental ingestion, dermal contact, and inhalation of ambient dust and volatile emissions. Current and future workers are also potentially exposed to VOCs in subsurface media (i.e., subsurface soil and groundwater) via the VI pathway and the eventual inhalation of indoor air.

- **Current and Future Construction Workers:** Construction workers could be exposed to surface soil and subsurface soil (0 to 12 feet bgs) through incidental ingestion, inhalation of particulates or volatile emissions, and dermal contact. The construction worker may also become exposed to groundwater less than 12 feet bgs during work activities (e.g., excavation). Although the standard operating procedure is to pump water from trenches, precluding groundwater inundation during construction and maintenance activities, potential routes of exposure were conservatively evaluated. Dermal contact and inhalation of ambient dust and volatile emissions were conservatively included as potentially complete pathways for exposure to the shallowest groundwater (less than 12 feet bgs), which is present only in EUs 4, 7, and 8 (Figure 2-4).

- **Current and Future Intrusive Maintenance Worker:** Intrusive maintenance workers could be exposed to surface, subsurface, and deeper soil (0 to 20 feet bgs) during deep trenching work/ underground utility repair via incidental ingestion, particulate or volatiles inhalation, and dermal contact. Intrusive maintenance workers may also be exposed to shallow groundwater (less than 20 feet bgs) during work activities (e.g., excavation) because sewers exist at this depth at the facility. Although the standard operating procedure is to pump water from trenches, precluding groundwater inundation during construction and maintenance activities, potential routes of exposure were conservatively evaluated. Dermal contact and inhalation of ambient dust and volatile emissions were conservatively included as potentially complete pathways for exposure to shallow groundwater (less than 20 feet bgs), which is present across the facility (including EU-1, the WWTU), with the exception of EU-2 (i.e., SWMU 19).

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- Recreational anglers in the Kanawha River that could be exposed to groundwater constituents that may discharge to the river, be taken up by fish in the water column of the river, and subsequently ingested with fish tissue.

2.7.1 Direct Contact with Soil and Shallow Groundwater

Estimated human health risks for potentially complete exposure pathways for soil and shallow groundwater (less than 20 feet bgs, where applicable), expressed as ELCRs and non-cancer hazard indices (HIs), are documented in various risk studies and reports listed above. ELCRs are compared to a threshold of 1 $x10^{-4}$, the upper end of USEPA's risk management range of $1x10^{-6}$ to $1x10^{-4}$, and non-cancer HIs are evaluated against the threshold of 1 (USEPA 1989, 1991) to assess the need for further action.

Human health risks were calculated for each EU with the exception of SWMUs that are former landfills (SWMUs 1, 2, 6, and 11). In the case of the landfill SWMUs, the exposure pathways are incomplete due to (current or planned) institutional controls (ICs). Therefore, landfill SWMUs are addressed separately in relevant subsections for each SWMU, as presented in Section 3.

A summary of the carcinogenic and non-cancer human health risk estimates, evaluated using the available data in each area, is included in Tables 2-2 and 2-3 for non-lead and lead constituents, respectively. Exposure scenarios and the associated EUs with risk estimates greater than thresholds are as follows:

- Construction workers exposed to subsurface soil (0 to 12 feet bgs) in EU-1; the HI of 2 is driven by elevated naphthalene concentrations;
- Construction workers exposed to subsurface soil (0 to 12 feet bgs) and intrusive maintenance workers exposed to deep soil (0 to 20 feet bgs) in EU-6; soils where the HIs are both equal to 2, driven by elevated benzene concentrations in the subsurface at CMS Area B;
- Industrial workers exposed to surface soil (0 to 2 feet bgs) and construction workers exposed to subsurface soil (0 to 12 feet bgs) in EU-7; the HIs are equal to 2 and 3, respectively, driven by naphthalene concentrations less than 3 feet bgs in the southwest corner of SWMU 7; and
- Workers potentially exposed to lead concentrations in EU-8, near the northeast corner of SWMU 13; lead was detected at 14,800 milligrams per kilogram (mg/kg) compared to the USEPA RSL comparison value for lead in industrial soil of 800 mg/kg. All other sample results were reported below the RSL comparison value.

Risk management or CA measures to be implemented to address soil or groundwater at these EUs are described in Section 3.

2.7.2 Groundwater to Surface Water – Fish Ingestion

Screening levels were developed for the groundwater-to-river/recreational angler exposure scenario and used for evaluating groundwater discharge conditions in the vicinity of the facility (CH2M 2012a). The groundwater concentrations evaluated from the site's perimeter wells located immediately adjacent to the Kanawha River indicated several exceedances of the human health screening levels. However, the pore water concentrations from samples collected at the groundwater/surface water interface indicated groundwater concentrations that might migrate to sediment result in risk estimates below thresholds for human receptors (CH2M 2012a, 2014a).

2.7.3 Vapor Intrusion

Previous evaluation has determined the VI pathway is insignificant for currently occupied site buildings (CH2M 2011a; 2014b; and 2016b). VI potential has historically been evaluated annually as part of the building inventory process (CH2M 2014d), which reviews current building use/occupancy information and the most recent, available groundwater data compared to current VISLs. A separate annual building inventory report has previously been prepared, but will not be prepared in the future. Instead, as agreed to during the 2015 annual agency meeting (June 2015), potential VI concerns due to changed conditions will be evaluated through the facility's groundwater monitoring and site inspection programs, which will assess the following:

- Potential changes in groundwater conditions (e.g., increasing concentrations, plume migration, changes in toxicity criteria, etc.) that are addressed as part of the current annual groundwater monitoring program; and
- Potential changes in site use, new construction, or changes in building occupancy that will be addressed during annual site inspection.

A changing condition in either program would trigger further evaluation of VI potential.

2.8 Summary of Ecological Risks

2.8.1 Habitats

The initial ecological risk assessment (ERA) conducted for the facility was presented in the Final Supplemental RCRA facility investigation (RFI) Report (CH2M 2005a). The ERA was based on USEPA guidance (USEPA 1997, 1998) and consisted of three key components: 1) problem formulation, 2) analysis, and 3) risk characterization. Exposure pathways for terrestrial receptors at the facility are incomplete or ecologically insignificant due to the highly developed nature of the facility (more than 95 percent of the total area is covered by buildings, gravel, asphalt, and/or concrete), which results in a lack of suitable habitat to support most terrestrial ecological receptors. As a result, the only complete exposure pathways evaluated in the ERA were for surface water and sediment in the adjacent Kanawha River.

Based on the findings of the ERA, subsequent investigations and ERAs were only required to evaluate potential risks to Kanawha River ecological receptors associated with pore water and/or sediment, as are summarized below.

2.8.2 Kanawha River Pore Water

Pore water characterization events were conducted during July 2009 and December 2012 to determine if VOCs in groundwater are discharging to the Kanawha River above protective levels. Results of the 2009 and 2012 pore water investigations indicate that VOC concentrations in pore water in the HPH and Tank 1010 areas were below established screening levels for the Kanawha River, with the exception of toluene at one location just south of HPH Area (CH2M 2013a). The exceedance associated with discharge of toluene from groundwater from the HPH Area is being addressed as part of the HPH Interim corrective measure.

2.8.3 Kanawha River Sediment

Sampling and analysis of sediments in the Kanawha River was initially implemented in August 2005 to understand and evaluate the potential risk from site-related constituents in groundwater to the Kanawha River benthic community. Seven samples were collected adjacent to the facility and two samples were collected upstream. These samples were analyzed for VOCs, SVOCs, and Total RCRA Metals. Because there were detections noted in the background samples at concentrations below the ecological screening criteria, the ecological screening criteria were used to evaluate the sediment data. As summarized in the 2005 *Migration of Contaminated Groundwater Under Control Environmental Indicator (EI) RCRIS code* document (USEPA 2005), there were a few exceedances of ecological screening criteria for sediment in the Kanawha River adjacent to the facility but the exceeding concentrations were either limited spatially, lie at depths for which there are no complete pathways to receptors, or were comprised of constituents believed to be unrelated to the facility.

A 2012 groundwater screening and risk evaluation concluded that site-specific groundwater screening levels (GWSLs) for metals were exceeded and that there was the potential for adverse effects to benthic organisms (CH2M 2012a). The site-specific GWSLs were based on the most conservative value among screening levels developed for human receptors and ecological receptors.[1] In recognition of the previously stated uncertainty, the report also concluded that naturally occurring concentrations of metals in surface sediments should be evaluated to better understand the potential risk of site-related metal constituents in groundwater to the Kanawha River benthic community.

Additional sediment samples were collected in December 2012 adjacent to (nine samples) and upstream from (three samples) the WWTU. The 2012 samples were analyzed for metals, including mercury, and total organic carbon to assess whether divalent (specifically cadmium, copper, lead, nickel, silver, and zinc, mercury) metals in sediment are likely to be bioavailable and toxic. Evaluation of the 2012 sediment data was presented in the *Groundwater to Surface Water and Sediment Risk Evaluation for Metals Report* (CH2M 2014a). The evaluation concluded that none of the screened compounds was required to be retained as a COC for sediment and that risk estimates associated with groundwater concentrations that migrate to sediment are below thresholds; therefore, further evaluation of sediment risk is not warranted (CH2M 2014a).

2.9 Risk Management or Corrective Action

Risk management or CA measures are required for the identified risks at the various facility media as defined in the HHRA and ERA documents. Proposed final remedies are presented in Section 3.

1 The lowest value, or most conservative value for ecological receptors (benthic receptors without site-specific dilution factor applied and pelagic organisms with dilution factor) and human receptors (fish ingestion pathway levels with dilution factor).

3 Proposed Corrective Measures

This section presents the corrective action objectives (CAOs) for the facility, describes the criteria used to evaluate proposed corrective measures, and then presents evaluation of the corrective measures for areas across the facility.

Interim corrective measures have already been evaluated, and an alternative chosen and reviewed with USEPA, and implemented for several of the SWMUs/AOCs. In these cases, the original remedy evaluation document is referenced and approval is requested for the interim corrective measure as the final corrective measure.

Several additional SWMUs/AOCs have been evaluated for corrective measures, and the evaluation is summarized in memorandum or report format, but the document has not been previously submitted to the USEPA. In these cases, the document is summarized in this CMP and included in its entirety in Appendix A (presented on the CD accompanying this report).

Due to complexity of the site and intended future land use, ICs will be utilized as corrective measures where appropriate, including soil management, management of waste in place, and restriction of groundwater use. Focused "hot spot" removal/control may also be utilized in conjunction with natural attenuation monitoring or other passive remedies, for groundwater remediation to prevent offsite migration of groundwater concentrations above criteria, and to reduce groundwater cleanup times by reducing contaminant mass.

3.1 Remedial Action Objectives

The overall objectives for corrective measures at the facility are to protect human health and the environment, and to satisfy RCRA CA requirements while identifying redevelopment and beneficial reuse opportunities. The remedial action objectives (RAOs) for the facility are as follows:

1. Manage waste materials and contaminated soil in place with appropriate barriers and institutional and engineering controls to prevent exposures that have the potential to result in risks above action thresholds (i.e., an ELCR of 1 x10^{-4} and an HI equal to 1; refer to Section 2.7.1).
2. Require institutional and engineering controls to prevent potential exposure from VI.
3. Reduce mass in soil and/or reduce infiltration rates to minimize leaching to groundwater underlying the facility.
4. Prevent human exposure to groundwater by prohibiting groundwater use at the facility.
5. Prevent groundwater from discharging to surface water at concentrations exceeding surface water quality criteria.
6. Use focused remedies (for example "hot spot" treatment coupled with monitoring progress toward meeting cleanup criteria).
7. Demonstrate no further action needed, where appropriate.

3.2 Remedy Evaluation Criteria

Final remedies selected for RCRA CA facilities are evaluated against the following threshold criteria (USEPA 2000):

- Protect human health and the environment based on reasonably anticipated land use(s), both now and in the future.

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- Achieve media cleanup objectives: Considers the ability of an alternative to meet CAOs for the facility.
- Control the sources of release: Considers the ability of an alternative to stop further environmental degradation by controlling or eliminating further releases that may pose a threat to human health and the environment.

The USEPA evaluation criteria were used to further evaluate the alternatives developed based on USEPA's "balancing/ evaluation" criteria (USEPA 2000):

- Long-term reliability and effectiveness: Considers the long-term reliability and effectiveness afforded by the technology. In addition, it considers the magnitude of risk that will remain at the area from residual contamination.
- Reduction of toxicity, mobility, or volume of wastes: Considers the ability of each technology to eliminate or reduce the toxicity, mobility, or volume of contaminated media at the area.
- Short-term effectiveness: Considers the risks to human health and the environment until the RAOs are achieved.
- Implementability: Considers the degree of difficulty anticipated in implementing a particular technology under the technical constraints posed by the facility.
- Cost: Considers the cost of a technology, including capital and long-term operations and maintenance (O&M).

Sustainability is another evaluation criterion to consider. Sustainable remediation encompasses the environmental and societal impacts of a corrective measure that are not necessarily considered in the threshold or balancing criteria. The sustainability metrics often are described in terms of resource use (e.g., fossil fuel consumption, water use, energy use, and land use) during implementation. Pollution from materials manufacturing, fuel consumption during transportation and equipment use, and electricity generation also are considered part of the environmental burden of a remedial technology. The overall effort (materials, labor, and equipment use) during implementation will be considered for each alternative as qualitative indicators of sustainability impacts. Alternatives that require more effort will generally have a higher impact and be considered poor sustainability performers.

3.3 Groundwater Measures

There are several measures already employed at the facility to address potential risk from dissolved groundwater contaminants. In addition to utilizing RAOs, performance standards were established to specifically address groundwater. A sitewide approach to groundwater is relevant to help streamline the process toward achievement of an RCRA CA "Complete" status.

The USEPA-approved sitewide groundwater monitoring program has been in place since 2011 (CH2M 2011d) and was updated with a revised program in 2014 (CH2M 2015b). The objectives of the sitewide program are to:

- Determine if concentrations in impacted areas are stable or decreasing;
- Monitor the perimeter of the site to ensure impacts remain onsite;
- Document improvement in water quality;
- Detect and respond to changes in site conditions; and
- Identify areas of the site where additional active remediation may be necessary.

Groundwater monitoring data are evaluated against the following three performance monitoring standards per the sitewide groundwater monitoring program (CH2M 2015b):

- **Onsite Containment** – structured to monitor groundwater adjacent to property boundaries and the

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Kanawha River to evaluate potential offsite migration of COCs in both the main chemical plant and WWTU areas. Groundwater concentrations from wells located along the facility boundaries will be compared to the most recent MCLs, where available, or RSLs for tap water based on a target cancer risk equal to $1x10^{-6}$ and an adjusted non-cancer HI of 0.1. Detected COC concentrations will also be compared to site-specific groundwater screening levels protective of river exposure pathways for humans and ecological receptors. The onsite containment performance standard is met if COC concentrations in the perimeter monitoring wells are either 1) below risk-based criteria, or 2) exhibit stable or decreasing concentration trends where no offsite impact is demonstrated or offsite impact is under a control (e.g., via ICs).

- **Plume Stability** - structured to verify concentrations of groundwater COCs onsite are stable or decreasing in magnitude (i.e., not migrating). A Mann- Kendall non-parametric statistical test is used for onsite groundwater wells to evaluate whether COC concentrations are statistically increasing or decreasing. If more than 90 percent of the wells at the main chemical plant and the WWTU areas exhibit stable or decreasing concentrations of COCs, and if all the sentinel well concentrations are stable or decreasing, then the plume stability standard is achieved.
- **Reduction in Constituent Mass** – structured to ensure groundwater quality continues to improve over time as measured by a reduction in the COC mass dissolved in groundwater at the main chemical plant. Mass reduction of dissolved site COCs in groundwater will be established using the Thiessen polygon method to evaluate changes in mass over time. This performance standard is achieved if a reduction in groundwater COC mass is measured for each key COC grouping at the facility (as defined in CH2M 2014b, 2015b), or if the COC mass reaches asymptotic conditions after exhibiting a decrease over time.

If the performance metrics for any of the performance standards are not met upon evaluation of groundwater monitoring data, a phased contingency plan will be triggered that consists of the following steps:

- Determine if the condition could potentially result in risks above thresholds. Applicable pathways will be evaluated, such as VI, drinking water, ecological impacts to surface water, etc.
- If the metric does not result in risks greater than thresholds, then monitoring will continue in accordance with the Performance Monitoring Plan (PMP) and the result will be noted in the annual compliance report.

If the metric results in the potential for risks above thresholds for human health or the environment, UCC will contact USEPA and WVDEP to discuss the appropriate path forward to address the risk. This may include evaluating available site data to determine the cause for the observed excursion from the metric; collecting additional data, if appropriate, to assess site conditions and the need for mitigation; or implementing a focused remedy to manage risk and achieve the RAOs for the facility. The excursion and steps taken to mitigate the excursion will be documented in an annual compliance report.

3.4 Institutional Controls

This section describes the general characteristics of various types of ICs that may be employed/required at individual EUs, with details regarding the basis for each IC employed at individual EUs in the sections that follow. Although area-specific remedies are being completed within various EUs, ICs are required across some of the EUs so that site conditions remain protective of human health and the environment prior to the time when media cleanup objectives are achieved. The ICs will be implemented using environmental covenants (ECs) or in accordance with requirements that will be outlined in a Materials Management Plant (MMP) that will be prepared as part of the Corrective Measures Implementation Plan (CMIP). Each IC type is summarized in Table 3-1 along with a statement as to why it is required and how it will be implemented.

ECs will be finalized following issuance of the final decision by USEPA and the RCRA Corrective Action Permit by WVDEP.

Table 3-2 summarizes the ICs and SWMUs/AOCs associated with each of the EUs. The following sections provide the proposed corrective measures for each EU as well as the basis for the any associated ICs (e.g., industrial/commercial land use restrictions, VI restrictions, groundwater use restrictions, prohibition of moving onsite soil to offsite locations).

The subsections that follow are arranged by EU in numerical order (EU-1 through EU-8) and contain a description of the various SWMUs/AOCs/other remediation areas within the EU, along with an evaluation of alternatives and a final proposed corrective measure alternative for each area. For the current landfills, which were not included in the HHRAs (Section 2.4), a brief description of impacts, potential exposures, and in-place or recommended engineering controls is also included.

3.5 EU-1

EU-1 is comprised entirely of the area covered by the WWTU, which includes SWMU 11 (the closed Chemfix landfill), six RCRA-closed ponds formerly associated with the WWTU, and three non-RCRA closed ponds (Figure 2-1).

The WWTU and the closed RCRA ponds and biobasins were managed under RCRA Part B Operating Permit number WVD 00 500 5509 issued by WVDEP in 2008 (WVDEP 2008), and as amended to include a CA module in March 2014 (WVDEP 2014; CH2M 2015a). Closure requirements and post-closure care of the RCRA-closed units and the WWTU will be incorporated into the RCRA Corrective Action Permit that will be issued by WVDEP following issuance of the final decision by USEPA. A report provided under separate cover to USEPA and WVDEP in October 2015, *Wastewater Treatment Unit Remedial Approach,* details the characteristics of those areas associated with the WWTU and describes the evaluation of and choice of corrective measures for this area of the Institute facility (CH2M 2015a). This CMP provides a high-level summary of the information contained in that document and the proposed final remedies for the areas within the WWTU.

Current and future workers have the potential to encounter soil (surface and subsurface) and shallow groundwater (less than 20 feet bgs) through direct contact. Naphthalene was identified as a COC in subsurface soil (Section 2.5 and Tables 2-2 and 2-3) requiring restrictions to mitigate potential direct contact exposures (Table 3-2). Additionally, groundwater impacts (see Appendix B [presented on CD] and Section 2.5.2) comprise metals, VOCs, and SVOCs at concentrations greater than tap water RSLs, MCLs, and/or VISLs. Ratios of some maximum detected concentrations to applicable screening levels are greater than 100, which suggests potential risks greater than thresholds (i.e., an ELCR of 1×10^{-4} and an HI equal to 1; refer to Section 2.7.1) and that COCs are present as related to an unrestricted use scenario. Overall, restrictions are required to mitigate potential future drinking water use and exposure to subsurface VOCs via the VI pathway. ICs planned for EU-1 comprise:

- Commercial/industrial land use across the EU;
- Groundwater use restriction across the EU (no drinking or irrigation uses allowed);
- VI restriction for occupied structures across the EU;
- Restriction for moving excavated EU-1 soil to offsite locations until evaluation of soil condition and concentrations is completed;
- Subsurface work restriction across the EU (Figure 3-1) and surface restrictions required for landfill SWMU 11; and
- Protection of CAs associated with the PTO facility that are located on the western portion of the Institute facility's WWTU. As per the Statement of Basis for the PTO facility, the following CAs will

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apply at the WWTU in consideration of conditions associated with PTO:

- Prohibit use of groundwater for purposes other than monitoring or remediation (already to be employed at EU-1/the WWTU as listed in Section 3.5).
- Require incorporation of a vapor control system into any new occupied buildings on the portions of the UCC Institute Facility's WWTU (already to be employed at EU-1/the WWTU as described in Section 3.5).
- Prohibit movement of soil or buried waste on the portions of the UCC Institute Facility unless it is determined the soil can be lawfully moved without posing a threat to the public health, safety, welfare, or the environment and that all such activities are in compliance with applicable federal, state, and local requirements (already to be employed at EU-1/the WWTU as listed in Section 3.5).
- Maintain the operation or performance of the recovery well(s) at the UCC Institute Facility that are associated with the SWMU 3 groundwater recovery system.

3.5.1 SWMU 11

3.5.1.1 SWMU-Specific Remedial Action Objectives

A primary CMP goal for the Institute facility is to satisfy RCRA CA requirements effectively and efficiently while identifying redevelopment and beneficial reuse opportunities (CH2M 2015c). RAOs have been identified for SWMU 11 based on site-specific conditions and RAOs for the entire facility. These RAOs are established in accordance with the RCRA framework to be protective of human health and the environment. The RAOs for SWMU 11 (CH2M 2015c) are as follows:

- Manage waste materials and contaminated soil in place with appropriate barriers and institutional and engineering controls to prevent potential exposures.
- Require institutional and engineering controls to prevent potential exposure from VI.
- Reduce mass in soil and/or reduce infiltration rates to minimize leaching to groundwater underlying the facility.
- Prevent human exposure to groundwater by prohibiting groundwater use at the facility.
- Prevent groundwater from discharging to surface water at concentrations exceeding surface water quality criteria.

3.5.1.2 Interim Corrective Measures

The original dimensions of the WWTU Holding Pond (later the Chemifix Landfill/SWMU 11) were described as 10 feet deep with a water volume of 64,000 cubic feet (CH2M 2015c). The pond was constructed by excavating down to groundwater. A 1-foot-thick clay liner was emplaced at the bottom of the pond. Waste was placed in the excavation such that the top of the waste was no higher in elevation than adjacent WV 25. Most waste was "fixed" into a solid form with the addition of kiln dust, cement, and/or other material placed in the landfill, and the area then covered with 6 to 8 inches of soil. Pond closure was reportedly completed in 1982, including grading the northern edge of the cover downward toward WV 25, installing fencing, and planting trees along the highway. The final SWMU 11 extent was approximately 6 acres in size.

UCC evaluated the thickness of the cover in 2012 to verify the site condition, and less than 6 inches of soil were noted in some areas (CH2M 2015c). Additional cover material was added to the existing soil cover in May through July 2014 for a minimum cover thickness of 12 inches (6 inches of clay and 6 inches of topsoil). The topsoil was hydro-seeded in August 2014 to establish a vegetative layer at the top, and supplemental seeding and mulching were conducted in July 2015 to improve areas with insufficient vegetation coverage. USEPA approved this work by approving the work plan for it (*Basis of Design SWMU 11 Cover Improvement Remedy*; CH2M 2013b) in an email dated May 29, 2014. A construction completion report is included as Appendix A9 (presented on CD) (CH2M 2015c).

3.5.1.3 Summary of Potential Exposures

Subsurface soil impacts exist at SWMU 11 where there is buried waste. Current and potential future exposure pathways for surface and subsurface soil are incomplete, however, because an engineered cover is in place over the SWMU and it will be managed in accordance with ICs appropriate for a former landfill.

3.5.2 Remainder of WWTU

3.5.2.1 Remedial Action Objectives

RAOs were developed in accordance with the RCRA framework to be protective of human health and the environment. The RAOs that apply specifically to the WWTU area (not including SMWU-11) are summarized as follows (CH2M 2015a):

- Prevent direct human exposure to groundwater by restricting groundwater use at the facility;
- Prevent exposure pathways for human receptors in areas where VI may be a potential concern; and
- Prevent human exposure to potentially contaminated subsurface media.

3.5.2.2 Interim Corrective Measures

The RCRA-closed ponds at the WWTU are in post-closure care and closure details (sludge removal, capping layers, vegetation, etc.) are specified in *Wastewater Treatment Unit Remedial Approach* (CH2M 2015a). The non-RCRA ponds were closed as described in the in *Wastewater Treatment Unit Remedial Approach* (CH2M 2015a) and continuing care comprises mowing of vegetation and cover maintenance.

When the RCRA-permitted areas were closed at the WWTU, one component of the RCRA Post-Closure Plan required the remediation of detected groundwater contamination from the surface impoundments. Two groundwater extraction wells were installed at the WWTU in 1988, adjacent to former Biobasins 1 and 2, to intercept groundwater flowing to the Kanawha River. The extraction wells reportedly each pumped approximately 8,000 gallons of water per day following installation. The extraction wells are still present but are not currently operating (as approved by Bill Wentworth of USEPA during a meeting on February 8, 2016) because data evaluation indicated there were no impacts to the river above risk thresholds (see Section 2.4) and the extraction wells were unnecessary. Groundwater monitoring wells were also installed in the late 1980s during the facility assessments, and again in the early 1990s. Groundwater monitoring at the WWTU is ongoing per the sitewide program described in Section 3.3 of this CMP.

Closed ponds and closure details are summarized as follows (CH2M 2015a):

- Biobasin 3 and Equalization basin. Sludge was removed and fill capped with 2 feet of compacted clay; closed by October 28, 1988.

- Emergency Basin/"Panic Pond." Sludge was removed from western portion of the basin and consolidated into the eastern portion, with 12 inches of low-permeability soil, 18 inches of compacted soil, and 2 inches of asphalt placed in the western portion. All pumpable sludge was removed from the eastern portion of the basin, with the remainder fixed in place and capped with 2 feet of low-permeability soil, a synthetic liner, a drainage layer, and a vegetative cover. Closure was complete in December 1989.

- No. 2 Sludge Pond. All sludge and obviously contaminated soil were removed, with 2 feet of low-permeability soil placed to cap the feature. Closure was complete in December 1989.

- Biobasins No. 1 and No. 2. Sludge was solidified in place and covered with non-hazardous fill composed of bottom and fly ash from the No. 1 coal burning steam plant. A soil cover and synthetic liner was then installed. Closure completion date is unknown, but the basins were reportedly removed from hazardous waste service on December 7, 1997.
- Non-RCRA former Sludge Ponds 1 and 3 were closed and revegetated by at least 1983 based on aerial photographic evaluation (no further documentation available).
- All remaining non-RCRA ponds and basins are noted as closed by 1998 (per aerial photographic evaluation).

The entire area comprised by the WWTU is currently enclosed by a chain-link fence, thereby mitigating potential unplanned exposures to surface and subsurface soils.

3.5.3 Evaluation of Proposed Final Corrective Measures for the WWTU

Remedial technologies, including ICs, monitoring, in situ treatments, excavation and disposal, and soil covers were evaluated for the WWTU using the USEPA criteria described in Section 3.2. Corrective measures were evaluated to meet the remedial objectives based on multiple criteria, including long- and short-term effectiveness, sustainability, implementability, and cost.

Groundwater corrective measures evaluated comprise the following:

- **Alternative 1 – ICs and Monitoring** – ECs to 1) prohibit the use of groundwater, except for remediation purposes (onsite and at the adjacent PTO facility) and 2) require evaluation of the VI pathway for future occupied structures. Completion of groundwater monitoring to assess changes in concentrations over time until MCLs/RSLs reached. Abandonment of existing groundwater recovery wells near former Biobasins 1 and 2.
- **Alternative 2 – Air Sparge/Soil Vapor Extraction (AS/SVE) and ICs, with Monitoring** – Installation and operation of vertical AS/SVE wells in the site interior until MCLs/RSLs achieved; abandonment of existing groundwater recovery wells near former Biobasins 1 and 2; ECs and monitoring identical to Alternative 1.
- **Alternative 3 – Groundwater Recovery System and ICs, with Monitoring –** Installation and operation of groundwater recovery wells in the site interior and increased use of existing recovery wells near former Biobasins 1 and 2 until MCLs/RSLs achieved; ECs and monitoring identical to Alternative 1.

Soil corrective measures evaluated comprise the following:

- **Alternative 1 – EC and IC** – EC to restrict land use to industrial/commercial; IC to manage potential future contact with subsurface soil; management of SWMU 11 as a landfill and the closed RCRA units with solidified sludge (former Biobasins 1 and 2, the eastern half of the Former Panic Pond) per previously approved closure plans.
- **Alternative 2 – Limited Soil Excavation** – Excavate soil outside of SMWU-11 and closed RCRA units exceeding residential screening levels and dispose offsite; management of SWMU 11 as a landfill and the closed RCRA units with solidified sludge (former Biobasins 1 and 2, the eastern half of the Former Panic Pond) per previously accepted closure plans.
- **Alternative 3 – Soil Cover** – ICs to 1) require maintenance of existing clean fill as soil cover over all RCRA units and areas outside of RCRA units and prevent direct contact with underlying impacted soil, and 2) prohibit excavation into the existing soil covers for RCRA units and areas outside of RCRA units; manage SWMU 11 as a landfill.

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3.5.4 Proposed Final Corrective Measures

The proposed final corrective measure for WWTU **groundwater** consists of Alternative 1: ICs and monitoring in accordance with the approved PMP (CH2M 2015b). Factors that contributed to its selection include the following:

- Alternative 1 effectively controls all current and potential future exposures, is simple and straightforward to implement, is protective of human health and the environment, is compatible with current and planned future land use, and is cost effective in comparison with Alternatives 2 and 3.
- Alternative 1 is more sustainable than the other alternatives because it does not generate additional carbon emissions or wastes for treatment.
- Groundwater impacts at the WWTU are low in concentration and implementation of active remediation is not necessary to protect human health or the environment.
- Alternative 2 not only costs more than Alternative 1, but would not remediate metals in groundwater (only VOCs and some SVOCs).

The proposed final corrective measure for WWTU **soil** consists of Alternative 1: EC and IC. Factors that contributed to its selection include the following:

- Alternative 1's proposed land use restriction is consistent with current and likely future land use.
- The soil covers already completed for SWMU 11 and the closed RCRA units are protective of human health and environment.
- Potential risks associated with current exposures are below thresholds; therefore, there is no reason to excavate subsurface soils, remove soil, or attempt to allow residential use.

Alternative 1 is more cost effective to implement than Alternative 3.

3.6 EU-2

EU-2 is comprised entirely of SWMU 19, also referred to as the Westside Landfill. No COCs were identified in soil (Section 2.5 and Tables 2-2 and 2-3) at SMWU 19. As such, no restrictions are required for surface or subsurface soil in EU-2 (Table 3-2). Additionally, only minimal groundwater impacts (see Appendix B [presented on CD] and Section 2.5.2) were identified in the groundwater in EU-2. Two constituents (arsenic and bis [2-ethylhexyl] phthalate) were detected at concentrations greater than both the associated tap water RSLs and MCLs. Arsenic concentrations (ranging from 0.0038 to 0.13 milligrams per liter [mg/L] compared to a tap water RSL equal to 0.000052 mg/L and an MCL of 0.01 mg/L) are within the range of background concentrations (0.00123 to 0.015 mg/L; CH2M 2014a). Bis (2-ethylhexyl) phthalate was detected at a concentration of 6 micrograms per liter (µg/L) compared to a tap water RSL of 5.6 µg/L and the MCL of 6 µg/L. This detected concentration is only slightly greater than the tap water RSL and is not indicative of a potential risk driver and it is equal to the MCL. No constituents were detected at concentrations greater than associated VISLs. Restrictions on groundwater use and consideration for the VI pathway are not required. ICs planned for EU-2 comprise the following:

- Commercial/industrial land use across the EU; and
- Restriction for moving excavated EU-2 soil to offsite locations until evaluation of soil condition and concentrations is completed.

The remainder of this section discusses site conditions associated with SWMU-19 and its proposed final remedy.

3.6.1 SWMU 19

The Westside Landfill, an approximate 24-acre parcel located between the main chemical plant and the WWTU, was not identified as a SWMU in the 1988 RCRA facility assessment (USEPA 1988) or in the 1990 CA permit. Results from a historical records review, site reconnaissance survey, and surface soil sampling effort are summarized in a 2015 report, *SWMU 19 Current Conditions Report* (Appendix A4 [presented on CD]; CH2M 2014c). In 1992, the Westside Landfill was labeled as SWMU 19 in the Verification Report (REMCOR 1992). Anecdotal evidence indicates that demolition wastes, primarily old metal equipment, plastic items, and dirt piles, were placed on both sides of the current tenant access road (bifurcates SWMU 19 from north-northwest to south-southeast as shown on Figure 2-4), likely between 1977 and 1992 when the area was fenced to eliminate further placement. Four soil borings and two wells advanced around the SWMU 19 perimeter in 1992 did not encounter waste or debris (CH2M 2014c).

Historical use of SWMU 19 was limited to equipment laydown and debris storage – no facility operations or intrusive activities are known to have taken place there. Low concentrations of metals in surface soil samples were within risk-based background levels (CH2M 2014c, Appendix A4). Two groundwater samples were collected from locations within SWMU 19 in 2000. As previously stated, bis[2-ethylhexyl] phthalate was detected at 6 μg/L versus an MCL of 6 μg/L). These sample results indicated an NFA recommendation after the 1992 investigation and again in 2001 (UCC 2001).

3.6.1.1 SWMU-Specific Remedial Action Objective

There have been no SWMU-specific RAOs established; however, the overall project objective of "demonstrating that corrective measures are complete for undeveloped portions of the facility" applies to the SWMU 19 area.

3.6.1.2 SWMU 19 Interim Corrective Measures

The interim corrective measure completed at SWMU 19 is placement of a fence around the unit in approximately 1992 to prohibit further placement of debris along roadways in this area, but the fence is no longer maintained.

3.6.1.3 SWMU 19 - Proposed Final Corrective Measure

Soil concentrations do not exceed industrial/commercial-based screening levels, but do exceed residential RSLs. Therefore, the final corrective measure will consist only of a land use restriction requiring industrial/commercial use and the sitewide control associated with not moving excavated soil from EU-2 offsite (Table 3-2).

3.7 EU-3

EU-3 is comprised of CMS Area A, AOC-3, and SWMU 12. Current and future workers have the potential to encounter soil (surface and subsurface) and shallow groundwater (less than 20 feet bgs) through direct contact, but no COCs were identified (Section 2.5 and Tables 2-2 and 2-3). As such, no restrictions are required for workers potentially exposed to soil and shallow groundwater in any portion of EU-3 (Table 3-2). Groundwater impacts (see Appendix B [presented on CD] and Section 2.5.2) do, however, comprise metals, VOCs, and SVOCs at concentrations greater than tap water RSLs, MCLs, and/or VISLs. Ratios of some maximum detected concentrations to applicable screening levels are greater than 100, which suggests potential risks greater than thresholds (i.e., an ELCR of 1×10^{-4} and an HI equal to 1; refer to Section 2.7.1) and that COCs are present as related to an unrestricted use scenario. As a result, restrictions are required to mitigate potential future drinking water use and exposure to subsurface VOCs via the VI pathway. ICs planned for EU-3 comprise the following:

- Commercial/industrial land use across the EU;

- VI restriction for occupied structures across the EU;
- Groundwater use restriction across the EU; and
- Restriction for moving excavated EU-3 soil to offsite locations until evaluation of soil condition and concentrations is completed.

CMS Area A is the only area in EU-3 that requires evaluation of corrective measures because SWMU-12 and AOC-3 were determined to require no further action. CMS Area A is comprised of SWMUs 18 and 22, and the Former Fluorocarbon Area, and was created as a means to collectively address CAs associated with these areas. SWMUs 18 and 22 as well as the Former Fluorocarbon Area have all been demolished and removed. These areas are briefly described as follows:

- SWMU 18: Consisted of a loading station where materials could be transferred from an overhead pipe rack to containers or trucks. Plant products were sampled or transferred through a series of spigots at the station. The loading lines were located over a concrete loading pad that was installed in early 1988 (REMCOR 1992).
- SWMU 22: This SWMU was the loading and unloading station from chemical transfer lines to tank trucks (REMCOR 1992).
- Former Fluorocarbon Area: Consisted of the former fluorocarbon production unit that operated from 1958 to 1978. Raw chemicals used at the former fluorocarbon production unit included VOC compounds carbon tetrachloride, chloroform, and PCE. Final products included trichlorofluoromethane (TCFM) and dichlorodifluoromethane (DCFM). The fluorocarbon production process generated hydrochloric acid as a process waste, which also contained residual amounts of fluorocarbons, PCE, chloroform, and/or carbon tetrachloride, with final products including TCFM and DCFM (CH2M 2016c).

A separately submitted report titled, *Former Fluorocarbon Unit Source Area Investigation and Remedial Approach Report* (CH2M 2016c) documents the results of soil and groundwater investigations conducted from 2011 to 2014 in the vicinity of the former fluorocarbon production unit to confirm the source of elevated VOC concentrations in groundwater in this vicinity. Four source areas (Subareas 3A through 3D) were found and delineated at the vicinity during investigations conducted between 2011 and 2014:

- Subarea 3A – Railroad unloading/limestone pit area
- Subarea 3B – Freon packaging area
- Subarea 3C – Fluorocarbon plant area
- Subarea 3D – Chlorocarbon storage area

Groundwater concentrations detected above the investigation-specific screening levels correspond directly to the identified vadose zone source areas for Subareas 3A, 3B, and 3C (CH2M 2016c). Additional information on the nature of the groundwater impacts in these subareas is summarized as follows:

- <u>Subarea 3A – Railroad unloading/limestone pit area</u>: carbon tetrachloride, chloroform, PCE, and TCFM impacts above the screening levels were identified in the shallow aquifer zone; only TCFM impacts above the screening level were identified in the deep aquifer zone.
- <u>Subarea 3B – Freon packaging area</u>: TCFM impacts in both the shallow and deep aquifer zones above the screening level were identified. Suspected nonaqueous phase liquid was observed in the aquifer zone at one soil boring location at a depth of approximately 35 to 37 feet bgs.
- <u>Subarea 3C – Fluorocarbon plant area</u>: PCE and TCFM impacts in both the shallow and deep aquifer zones above the screening level were identified; in addition, carbon tetrachloride impacts above the screening level were also identified in the shallow aquifer zone.

- Subarea 3D – Chlorocarbon storage area: carbon tetrachloride, PCE, and TCFM impacts to both the shallow and deep aquifer zones above the screening level were identified.

Vadose soils at the four subareas consist predominately of low-permeability materials such as silt and clay. Although soil impacts were identified in the vadose zone, it is not clear if COCs bound in the silt and clay portion of the vadose zone are providing a continuing source to groundwater. However, annual groundwater performance monitoring (CH2M 2016c) has established that decreasing concentration trends are not observed in the Former Fluorocarbon Area and active groundwater remediation is being implemented in order to achieve the site-specific RAO (Section 3.7.3).

3.7.1 CMS Area A-Specific RAO

The following site-specific RAO was developed for the Former Fluorocarbon Area (CH2M 2016c):

- Decreasing concentration trends in groundwater (as measured during annual performance monitoring). Treat groundwater plumes in vicinity of source areas where the remedy is practical to enhance the attenuation of groundwater constituents.

3.7.2 CMS Area A--Interim Measures

Remediation at the Former Fluorocarbon Area began with remediation at the ENB Area in early 1996 with the installation of an AS/SVE system at the ENB Central location (Figure 2-1). Two more AS/SVE systems were installed at the ENB South and ENB North areas from late 1996 to mid-1997. The AS/SVE systems remained in operation through early 2002. Two groundwater extraction wells were installed in late 1999 at the ENB North area. Pumping at these extraction wells was discontinued after it was determined that continued operation did not significantly affect groundwater or off-gas vapor constituent concentrations. After conducting pilot testing using chemical oxidation and aerobic co-metabolism remediation approaches, a full-scale application of a soy oil-based aerobic co-metabolism approach was applied to the ENB North and Central areas in 2002 and 2003, and analytical data demonstrated significant reductions or elimination of target compounds (carbon tetrachloride, chloroform, PCE, TCFM, and DCFM) at both sites. Because of the success achieved at that time, remediation of these areas was terminated in late 2003 (CH2M 2009a).

Implementation of previous interim actions in the Former Fluorocarbon Area focused on groundwater, and results support the premise that an active RA for groundwater is likely to achieve the site-specific RAO. Therefore, a target treatment zone (TTZ) was developed for groundwater at each Former Fluorocarbon Subarea (3A through 3D), fulfilling the RAO to implement active remediation of the groundwater plume in the vicinity of source areas (CH2M 2016c). The vertical groundwater TTZ extends from the top of a sandy aquifer (approximately 17 feet bgs) to bedrock (approximately 55 feet bgs). Once the source area concentrations are reduced, it is anticipated that natural attenuation will be effective at remediating the more widespread, lower concentrations of COCs in groundwater.

3.7.3 CMS Area A - Evaluation of Proposed Final Corrective Measures

The evaluation of CM Alternatives for the CMS Area A, comprising Subareas 3A, 3B, 3C, and 3D, is documented in "*Former Fluorocarbon Unit Source Area Investigation and Remedial Approach Report*" (CH2M 2016c). As previously noted, active remediation will focus on groundwater and not on vadose zone soils. Alternatives evaluated for the CMS Area A comprise the following (CH2M 2016c):

- **Alternative 1 – AS -** AS injects air into the subsurface saturated zone and vents through the unsaturated zone to remove volatile and subsurface contaminants. It is typically used in combination with SVE, which controls the vapor plume migration by a series of extraction wells that create a negative pressure in the unsaturated zone and removes contaminants. Soil fracturing is required to implement vapor extraction wells due to the tight clay materials present in the vadose zone at the Former Fluorocarbon Area. Extracted vapors will require vapor treatment.

- **Alternative 2 - AS with Co-Metabolic Process** – Substrate is injected with an oxygen source into the subsurface through AS wells to remove subsurface contaminants and stimulate in situ microbial activity, thereby stimulating aerobic co-metabolism and decreasing concentrations of COCs. Aerobic co-metabolism can biodegrade the site COCs, which normally biodegrade under anaerobic conditions. Soil fracturing is required to implement vapor extraction wells due to the tight clay materials present in the vadose zone at the Former Fluorocarbon Area. Extracted vapors will require vapor treatment.
- **Alternative 3 - Aerobic Co-Metabolic Bioremediation (ACB) via Co-Metabolite-Enhanced Biosparging** - Similar to AS described in Alternative 2 but the rate of sparging is lower. Sufficient oxygen is provided for the native microbial population to promote biodegradation. Substrate injected with an oxygen source will stimulate aerobic co-metabolism. Aerobic co-metabolism can accelerate biodegradation of the site COCs, which normally biodegrade under anaerobic conditions. Vapor extraction wells are not required (as with Alternatives 1 and 2) because biosparge is operated at low air flows.

Administrative and ICs, natural attenuation monitoring, and post-shutdown groundwater monitoring to determine concentration trends are all components of each alternative. If statistically significant increasing concentrations of COCs are observed, indicating a continuing source present in the vadose zone, an evaluation will be conducted to determine the feasibility and effectiveness of implementing a targeted soil remedy in order to meet the site-specific RAO.

3.7.4 CMS Area A - Proposed Final Corrective Measures

Alternative 3, Aerobic Co-Metabolic Bioremediation (ACB) via Co-Metabolite-Enhanced Biosparging is proposed as the final corrective measure. Factors that contributed to its selection include the following:

- The same remedy was successfully and effectively implemented at the ENB areas at the Institute facility. The technology has also been demonstrated to be effective at other facilities in the United States (Battelle 2008).
- Alternative 3 can be easily implemented because the equipment, vendors, and materials are readily available and previous smaller-scale implementation has been completed at the facility for interim remedies.
- Alternative 3 has fewer limitations than Alternatives 1 or 2 because the air is injected at low-flow rates and a vapor control system is not necessary.
- It would be more challenging to control vapors under Alternatives 1 and 2 because air would be injected into groundwater beneath a low-permeability horizon, making it difficult to monitor where vapors go, whereas Alternative 3 has low-flow injection rates.
- Alternative 3 is safer to implement than Alternatives 1 or 2 because hydrogen fluoride gas (a toxic substance) would be formed during combustion/treatment of process vapors (due to the presence of fluorinated hydrocarbons in the process vapor stream) as part of Alternatives 1 and 2.

3.8 EU-4

EU-4 is comprised of AOC-4, SWMUs 5, 8, and 10, and a large area outside of/not included within the SWMUs/AOC boundaries. SWMU 5 is the only SWMU/AOC not previously screened out of further evaluation (Table 2-1). Current and future workers have the potential to encounter soil (surface and subsurface) and shallow groundwater (less than 12 feet bgs) through direct contact, but no COCs were identified (Section 2.5 and Tables 2-2 and 2-3). As such, no restrictions are required for workers potentially exposed to soil or shallow groundwater in EU-4 (Table 3-2). Groundwater impacts (see Appendix B and Section 2.5.2) do, however, comprise metals, VOCs, and SVOCs at concentrations greater than tap water RSLs, MCLs, and/or VISLs. Ratios of some maximum detected concentrations to applicable screening levels are greater than 100, which suggests potential risks greater than thresholds (i.e., an ELCR of 1 $x10^{-4}$ and an HI equal to 1; refer to Section 2.7.1) and that COCs are present as related to an unrestricted use scenario. Overall, ICs are required to mitigate potential future drinking water use and exposure to subsurface VOCs via the VI pathway. ICs planned for EU-4 based on HHRA data comprise the following:

- Commercial/industrial land use across the EU;
- VI restriction for occupied structures across the EU;
- Groundwater use restriction across the EU; and
- Restriction for moving excavated EU-4 soil to offsite locations until evaluation of soil condition and concentrations is completed.

The remainder of this section discusses site conditions associated with SWMU 5 and its proposed final remedy. There is also a small portion of the CMS Area B that extends across the EU-4 boundary. The proposed remedy for CMS Area B is evaluate as part of EU-6.

3.8.1 SWMU 5

According to the *Waste in Place Current Conditions Report SWMU 1 and SWMU 5* (CH2M 2015f; Appendix A2 [presented on CD]), SWMU 5, formerly called the #1 Fly Ash Pond, is in the southwestern quadrant of the facility (Figure 2-1) and is an open, unoccupied space (*Waste in Place Current Conditions Report SWMU 1 and SWMU 5* [CH2M 2015f; Appendix A2]). Currently, the area lies adjacent to a fenced electrical substation (owned by APCO) between the railroad tracks and the Kanawha River. SWMU 5 is within the fenced facility boundary but access to the SWMU 5 area is not specifically restricted.

SWMU 5 was a pond approximately 110 feet by 160 feet by 10 feet deep, in service from 1942 until 1985 to receive bottom ash (clinkers). The ash that collected in the pond during this time was periodically removed and sold for landfill material. The pond then served as a holding basin for boiler wash water being held for analysis before discharge. Historical analysis (circa 1979, 1985, and 1986) of pond waste soil and “washings” indicated the material was non-hazardous. Additional soil from the construction of a Rhodimet Unit, reportedly “screened clean,” was added to the pond in 1992 and covered with 4 feet of clean soil (CH2M 2015f, Appendix A2 [presented on CD]).

In September and October 2012, soil borings were advanced to approximately 15 feet bgs at SWMU 5 to characterize contents (Figure 3-2). A cover approximately 5 feet thick (sand, silt, gravel, some brick debris) was identified over black material described as fly ash. Depths of the black material ranged from 6 to 14 feet bgs in the eastern portion of the previously defined SWMU boundary (Figure 3-2).

Additional sampling activities were conducted in 2015 to aid in the characterization of subsurface soils at SWMU 5. Two samples were collected below the 5 feet of cover material and results were consistent with historical investigations (detections of metals constituents). Material indicative of fly ash was identified in the northwestern quadrant of the SWMU but not found in the southeastern quadrant. The soils analyses were evaluated and included as part of the HHRA (CH2M 2016a). Carcinogenic risk estimates were within USEPA’s risk management range of $1x10^{-6}$ to $1x10^{-4}$, and noncancer HIs were below the threshold of 1 for each target organ.

3.8.1.1 SWMU-Specific Remedial Action Objectives

There have been no RAOs established specific to SWMU 5 but the overall facility RAOs apply.

3.8.1.2 SWMU 5 Interim Corrective Measures

SMWU 5 was covered with 4 feet of clean soil in 1992.

3.8.1.3 SWMU 5 - Proposed Final Corrective Measures

Risks associated with potential worker exposures in SWMU 5 are below thresholds. Groundwater exposures as related to an unrestricted use scenario (e.g., residential tap water use) will be addressed on a sitewide basis; therefore, the final corrective measure at SWMU 5 will consist of those actions associated with EU-4 (e.g., restriction to industrial/commercial use, evaluation of excavated soil to be moved offsite, groundwater use restrictions, and VI restrictions for occupied structures).

3.9 EU-5

EU-5 is comprised of SWMUs 2, 4, 6, 16, and 17, as indicated on Figure 2-4. There is also a small portion of CMS Area A that extends east onto EU-5 from EU-3; however, CMS Area A characteristics and data are entirely accounted for with EU-3. Current and future workers have the potential to encounter soil (surface and subsurface) and shallow groundwater (less than 20 feet bgs) through direct contact, but no COCs were identified (Section 2.5 and Tables 2-2 and 2-3). As a result, no restrictions are required for direct contact exposures to soil or shallow groundwater in EU-5 with the exception of the SWMUs 2 and 6 landfill (Table 3-2). Groundwater impacts (see Appendix B [presented on CD] and Section 2.5.2) do, however, comprise metals, VOCs, and SVOCs at concentrations greater than tap water RSLs, MCLs, and/or VISLs. Ratios of some maximum detected concentrations to applicable screening levels are greater than 100, which suggests potential risks greater than thresholds (i.e., an ELCR of 1 $\times 10^{-4}$ and an HI equal to 1; refer to Section 2.7.1) and that COCs are present as related to an unrestricted use scenario. As a result, restrictions are required to mitigate potential future drinking water use and exposure to subsurface VOCs via the VI pathway. ICs planned for EU-5 comprise the following:

- Commercial/industrial land use across the EU;
- VI restriction for occupied structures across the EU;
- Groundwater use restriction across the EU;
- Restriction for moving excavated EU-5 soil to offsite locations until evaluation of soil condition and concentrations is completed.
- Surface exposure and subsurface work restriction for landfill SWMUs 2 and 6 (Figure 3-1); and
- Protection of CAs in place at SWMUs 2 and 6.

The remainder of this section discusses site conditions associated with specific areas of EU-5 that have not previously been identified for NFA, and the proposed final remedies for each area.

3.9.1 SWMUs 2 and 6

SWMU 2 and 6 are comprised of the No. 2 Ash Pond and No. 2 Fly Ash Landfill, respectively. They are addressed together because the Ash Pond was built on top of a section of the 4-acre Fly Ash Landfill. A grass-covered clay cover that is approximately 2 feet thick around the pond area covers the landfill and has a laboratory permeability of approximately 3- to 4 $\times 10^{-8}$ centimeters per second (cm/s) (UCC 2001). Landfilled materials include cinders, coal, glass, and black organic oil and sludge mixed with ordinary gravel and sand. Site investigation activities and visual inspections performed by CH2M and previous consultants had determined that the cover thickness over the No. 2 Fly Ash Landfill was inconsistent and in some areas less than 6 inches thick (Kemron 2003).

Historical groundwater data (circa 2000) in the vicinity of SWMUs 2 and 6 indicate concentrations of metal compounds detected above screening criteria (CH2M 2009a; CCR Appendix A, Table A-1 [presented on CD]). Groundwater is being addressed via the sitewide groundwater monitoring program.

3.9.1.1 SWMU-Specific Remedial Action Objectives—SWMUs 2 and 6

- Manage waste materials and contaminated soil in place with appropriate barriers and institutional and engineering controls to prevent potential exposures through direct contact;
- Require institutional and engineering controls to prevent potential exposure from VI; and
- Reduce infiltration rates to minimize leaching to groundwater underlying the facility.

3.9.1.2 SWMUs 2 and 6 Interim Corrective Measures

Interim measures at SWMUs 2 and 6 began with initial covers placed to provide protection to fill contents. Additional work to cover these SWMUs was completed in August 2008 when the cover thickness was increased to at least 6 inches of clay across the 33,000-square-foot region (CH2M 2010). Compacted clay was placed in an 8- to 10-inch lift. A minimum of 4 inches of topsoil was placed and compacted over the compacted clay cover, and a seed mix of native grasses was planted and watered. Cover vegetation repair was required and accomplished in November 2009, resulting with the now-established grass cover.

3.9.1.3 SWMUs 2 and 6 - Summary of Potential Exposures

The established landfill cover across SWMUs 2 and 6 prevents direct contact at the surface and planned ICs prevent potential future contact with waste materials buried in the subsurface.

Groundwater concentrations from wells included in the PMP that are located in EU-5 (where SWMUs 2 and 6 are situated) exceed VISLs and drinking water screening levels.

3.9.1.4 SWMUs 2 and 6 - Evaluation of Proposed Final Corrective Measures

Corrective measures were evaluated for SWMU 2 and 6 to meet the remedial objectives based on multiple criteria, including long- and short-term effectiveness, sustainability, implementability, and cost. Corrective measures evaluated comprise the following:

- Alternative 1 – Maintain Cover – Manage as a Landfill with ICs:
  - Utilize the existing clay and topsoil cover and manage as a landfill;
  - Prohibit construction of structures on the landfill or provide equivalent protection from direct contact and obtain written approval from WVDEP/USEPA for proposed modifications (such as for a parking lot or similar structure);
  - IC to address potential future contact with impacted soil or waste material (require invasive earthwork to be conducted under proper supervision and utilizing appropriate safety precautions);
  - IC (signs at the site and administrative requirements for intrusive activities and contractors) to address potential future contact with impacted soil or waste material; and
  - Maintenance of cover material for continued protection of direct contact.
- Alternative 2 – Source Removal:
  - Remove an estimated 12,200 cubic yards of waste material from the landfill and transport it to an offsite disposal facility

3.9.1.5 SWMUs 2 and 6 - Proposed Final Corrective Measures

The proposed final corrective measure for SWMUs 2 and 6 consists of Alternative 1, Maintain Cover – Manage as a Landfill with ICs. Factors that contributed to its selection include the following:

- The soil cover was installed as an interim action due to its easy implementability, cost, and short-term effectiveness.

- The soil cover has been evaluated and inspected, and is effective at meeting project- and site-specific RAOs.
- The soil cover is a reliable technology and easily maintained for long-term prevention of exposure to buried waste.
- The soil cover reduces infiltration into buried waste and, therefore, leaching to groundwater.
- Removal and transport of waste materials during implementation of Alternative 2 would generate significant carbon emissions, potential safety issues to workers and to the community, and is simply a relocation of the landfilled materials without reduction in toxicity or volume.
- Alternative 2 was rejected because removal of waste materials from the landfills is not considered a practical option due to the estimated volume of waste material present. The cost of removal and disposal is excessively expensive at an estimated cost of more than $2 million (assuming non-hazardous disposal).
- Alternative 1 is sustainable in terms of long-term effectiveness and cost, while Alternative 2 would utilize resources to simply remove and transport the waste material from one landfill to another.

In addition, Ash Pond No. 2 will be closed by removing the contents to the base of the pond and placing clean backfill into the pond along with providing a vegetated soil cover to match the existing closed landfill.

3.9.2 SWMU 4

SWMU 4 was formerly a landfill and subsequently a synthetic gas (Syngas/Praxair) unit. Toluene diisocyanate (TDI), toluene diamine, and other unit wastes may have been disposed of in a 100-foot by 50-foot by 10-foot-deep landfill (CH2M 2009a). Waste materials are believed to have been removed prior to construction of the synthetic gas unit.

Several phases of soil and/or groundwater investigation activities have occurred at SWMU 4 (REMCOR 1992; UCC 2001; Kemron 2003; CH2M 2016a). Four soil borings completed to depths of 22 feet at SWMU 4, within the previously reported boundaries of the landfill, indicated only soil and no waste material (REMCOR 1992). VOCs and SVOCs were detected during the RFI in the soil and groundwater at SWMU 4. Chlorobenzene and benzene were detected in groundwater downgradient of SWMU 4 in the early 2000s, but only slightly above risk-based screening levels (Kemron 2003).

3.9.2.1 SWMU-Specific Remedial Action Objectives

There have been no SWMU-specific RAOs established and, therefore, the sitewide RAOs apply.

3.9.2.2 SWMU 4 Interim Corrective Measures

Much of the waste material was removed when the site was prepared for construction of the Syngas Unit (REMCOR 1992) but documentation of the removal and disposal is not available. Removal, however, was confirmed in 1991 during completion of the four soil borings (to 22 feet bgs) within the former landfill boundaries (REMCOR 1992).

3.9.2.3 SWMU 4 - Proposed Final Corrective Measures

Risk estimates are below thresholds (i.e., an ELCR of 1×10^{-4} and an HI equal to 1; refer to Section 2.7.1); therefore, final corrective measures beyond those actions associated with EU-5 (e.g., restriction to industrial/commercial use, evaluation of excavated soil to be moved offsite, groundwater use restrictions, and VI restrictions for occupied structures) are not specifically required for SWMU 4.

3.9.3 SWMUs 16 and 17

These two SWMUs are in close proximity to one another and have historically been addressed together. SWMU 16 consists of the Chemical Cleaning Building (334), which is used for miscellaneous cleaning operations using both chlorinated and non-chlorinated solvents. SWMU 17 consists of a gravel area that was historically used for burning flammable residues from metal parts and other materials. Building 334 (SWMU 16) is currently in service and the area designated as SWMU 17 is an open area covered by gravel and asphalt.

Investigation activities at SWMUs 16 and 17 in 1992 determined minimal metals impacts occurred in subsurface soils (beryllium and nickel). Several phases of investigation activities revealed significant VOC groundwater impacts in the area. The investigations performed in 2012 determined the VOC groundwater impacts were not related to sources at SWMUs 16 and 17 but rather to historical activities in the Former Fluorocarbon Area (part of CMS Area A) to the north and northwest (CH2M 2016c).

3.9.3.1 SWMU-Specific Remedial Action Objectives—SWMUs 16 and 17

There have been no SWMU-specific RAOs established; however, the sitewide RAOs apply.

3.9.3.2 SWMUs 16 and 17—Interim Corrective Measures

There have been no SWMU-specific corrective measures applied at SWMUs 16 and 17.

3.9.3.3 SWMUs 16 and 17 - Proposed Final Corrective Measure

Risk estimates for potential worker exposures are below thresholds; therefore, final corrective measures beyond those actions associated with EU-5 (e.g., restriction to industrial/commercial use, evaluation of excavated soil to be moved offsite, groundwater use restrictions, and VI restrictions for occupied structures) are not specifically required for SWMUs 16 and 17. Groundwater impacts as related to an unrestricted use scenario are being addressed by the sitewide groundwater monitoring program (CH2M 2015b) as well as by CAs at upgradient CMS Area A.

3.10 EU-6

SWMUs within the EU consist of SWMUs 9, 14, and 23 as well as CMS Area B (Figure 2-4). The areas for which final corrective measures proposals must be documented in EU-6 are SWMU 9 and CMS Area B because SWMUs 14 and 23 have NFA determinations (Table 2-1). The proposed remedy for CMS Area B is covered in this section – note that CMS Area B extends westward into the boundary of EU-4, but the entire CMS Area B is addressed in this EU-6 section.

Current and future workers have the potential to encounter soil (surface and subsurface) and shallow groundwater (less than 20 feet bgs) through direct contact (Section 2.5 and Tables 2-2 and 2-3), and the HHRAs identified benzene as a COC in subsurface soil in CMS Area B. As a result, restrictions are planned to mitigate potential risks (Table 3-2). Additionally, groundwater impacts (see Appendix B [presented on CD] and Section 2.5.2) comprise metals, VOCs, and SVOCs at concentrations greater than tap water RSLs, MCLs, and/or VISLs. Ratios of some maximum detected concentrations to applicable screening levels are greater than 100, which suggests potential risks greater than thresholds (i.e., an ELCR of 1×10^{-4} and an HI equal to 1; refer to Section 2.7.1) and that COCs are present in groundwater as related to an unrestricted use scenario. As a result, restrictions are required to mitigate potential future drinking water use and exposure to subsurface VOCs via the VI pathway. ICs planned for EU-6 comprise the following:

- Commercial/industrial land use across the EU;
- Groundwater use restriction across the EU;
- VI restriction for occupied structures across the EU;

- Restriction for moving excavated EU-6 soil to offsite locations until evaluation of soil condition and concentrations is completed.
- Subsurface work restriction for CMS Area B (Figure 3-1); and
- Protection of CAs in place at CMS Area B.

The remainder of this section discusses site conditions associated with specific areas of EU-6 and the proposed final remedies for those areas.

3.10.1 SWMU 9

This unit consisted of two 26,000-gallon aluminum aboveground storage tanks (ASTs) — "Past Residue Storage Tanks 1037 & 1038," which were removed in 1990 from their location approximately 400 feet north of the Kanawha River. The tanks historically contained naphthol and acetone, respectively, and were mounted horizontally in concrete saddles over gravel. Several phases of investigation activities occurred at SWMU 9, including a river boundary investigation, which included areas to the south between SWMU 9, SWMU 23, and the Kanawha River. Metals, benzene, 1,2,4-trimethylbenzene, and naphthalene were detected above RFI screening levels at downgradient well locations and along the river boundary. Additional soil and groundwater samples were collected during an October 2006 sitewide RFI (CH2M 2009a). No soil impacts were identified and minimal VOC impacts were detected within the deep groundwater zone (several metals, 1,2,4-trimethylbenzene, and naphthalene above screening levels; UCC 2001). Benzene was detected above standards in groundwater in 2008 (CH2M 2009a).

No additional activities have taken place since the completion of the CCR. SWMU 9 is currently an open area covered with gravel.

3.10.1.1 SWMU-Specific Remedial Action Objectives

There have been no SWMU-specific RAOs established; however, the sitewide RAOs apply.

3.10.1.2 SWMU 9 Interim Corrective Measures

The former ASTs were removed and properly disposed in 1990.

3.10.1.3 SWMU 9 - Proposed Final Corrective Measure

Risks associated with potential worker exposures in SWMU 9 are below thresholds. Groundwater exposures as related to an unrestricted use scenario (e.g., residential tap water use) will be addressed on a sitewide basis; therefore, the final corrective measure at SWMU 9 will consist of those actions associated with EU-6 (e.g., restriction to industrial/commercial use, evaluation of excavated soil to be moved offsite, groundwater use restrictions, and VI restrictions for occupied structures).

3.10.2 CMS Area B

CMS Area B is comprised of former operational areas north of the Kanawha River (Figure 2-4), including the "Tank 1010" and "HPH" areas. Groundwater impacts in the CMS Area B are being addressed by the sitewide groundwater monitoring program (CH2M 2015b).

The description of both the Tank 1010 and HPH areas, interim measures completed, and corrective measures evaluations (including groundwater trends and analysis) are summarized in separate subsections below.

3.10.2.1 Tank 1010 Area

Tank 1010 Area Description and Background. The location of the Tank 1010 Area is shown on Figure 2-4. Tank 1010 itself is a 1.47-million-gallon AST that stored benzene for nearly 40 years (1943 through 1981), and that was associated with the former styrene production unit at the facility.

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Historically, benzene was unloaded from railcars along a railroad spur north of the tank farm. Workers would connect flexible hosing from a port at the bottom of the railcar to the pipes within a pipe trench and unload the contents into the ASTs with the aid of a pump located near each AST (Tank Nos. 1006 through 1010). The pipe trench contained three drains that drained liquid that entered the piping trench to a nearby cesspool. The cesspool is no longer present, and its former location is unknown (Appendix A5 [presented on CD]; CH2M 2011b). Since 1981, the tank has been in service for the glycol process unit and is currently used for the storage of anti-freeze-grade ethylene glycol.

Investigation activities began at the Tank 1010 area in 2009 in an effort to identify the source of elevated VOC concentrations, specifically benzene, detected in the groundwater during investigation of the HPH Area, located immediately west of the Tank 1010 Area. Investigation activities completed at the Tank 1010 Area in 2010 and 2011 identified source concentrations of benzene in soil and groundwater north of Tank 1010 between the secondary containment area and the former piping trench historically used to transfer benzene from railcars to the tank (CH2M 2016d).

Pore water samples were collected in 2012 to assess potential discharges of groundwater COCs to the Kanawha River hydraulically downgradient of the Tank 1010 Area. Benzene and ethylbenzene were not detected in the pore water samples and those compounds that were detected (toluene, xylenes, naphthalene) did not have concentrations exceeding the site-specific GWSLs established to protect potential human and ecological receptors in Kanawha River surface water (CH2M 2012a, 2013a).

Tank 1010 Area - Specific Remedial Action Objectives. The RAOs retained specific to the Tank 1010 Area are (Appendix A6 [presented on CD]; CH2M 2016d):

- Reduce source area VOC mass (primarily benzene) in source area north of Tank 1010;
- Improve groundwater quality consistent with the groundwater performance monitoring plan;
- Address VI risks with active soil/groundwater remediation or engineering controls, as necessary; and
- Prevent unacceptable direct contact with soil and groundwater through engineering and/or ICs (e.g., soil management plan) (to be addressed by the facility's MMP).

Tank 1010 Area - Evaluation of Proposed Interim and Final Corrective Measures.

The following remedial alternatives were evaluated for the Tank 1010 Area for Interim Actions and Final Corrective Measures (Appendix A6 [presented on CD]; CH2M 2016d):

- Alternative 1 – Excavation, Ex-Situ Onsite Treatment, and Offsite Disposal or Onsite Reuse
- Alternative 2 – Excavation, Offsite Treatment, and Offsite Disposal
- Alternative 3 – In Situ Chemical Oxidation (ISCO) via Injection
- Alternative 4 – Administrative and Institutional Controls
- Alternative 5 – Natural Attenuation Monitoring

Tank 1010 Area - Interim Measures. Alternative 3 (ISCO via Injection) was selected to implement as interim remedy to address benzene concentrations in source area soils and groundwater at the Tank 1010 Area. Inactive railroad sidings and inactive subsurface pipes in a concrete trench associated with former Tank 1010 filling operations were removed in October 2014. The western and central portions of the concrete trench were also demolished with the eastern portion of the trench remaining due to pipes associated with Tank 1009 operations (Appendix A6; CH2M 2016d).

Pilot testing was performed in November and December 2014 at the Tank 1010 source area using approximately 7,300 gallons of Cool-Ox™ injected into the subsurface using direct-push technology (DPT) injection points placed on 4-foot centers in the 2,600 square foot TTZ. Cool-Ox™ is a proprietary ISCO reagent developed by Deep Earth Technologies, Inc. (DTI). The patented Cool-Ox™ process is an in situ remediation technology that combines controlled chemical oxidation with accelerated biodegradation subsequent to the oxidation phase. Cool-Ox™ was selected as the reagent following a detailed evaluation of reagent options because it is effective in addressing the site-specific COCs (primarily benzene) and because the reaction is controllable and does not create heat, eliminating safety concerns related to the high COC concentrations and proximity to sensitive structures. The TTZ size was limited to an area smaller than the source area by accessibility related to existing railroad tracks to the north, a major utility corridor immediately to the west, and facility infrastructure (active ASTs) to the south of the TTZ.

A second injection event was completed during December 2015 in a smaller subset of the TTZ to optimize delivery and target the highest observed adsorbed-phase benzene concentrations. A total of approximately 2,100 gallons of Cool-Ox™ was injected into the subsurface using DPT injection points placed on 3-foot centers in the 945 square foot TTZ.

Results from pre- and post-injection monitoring for groundwater and soil sampling indicates the following:

- No trend in shallow groundwater results from the TTZ: increases in some monitoring wells and reductions in other monitoring wells.
- Overall reductions in benzene concentrations in soil between pre- and post-injection sampling were not significant compared to the overall mass in the source area. Some mass reduction was likely achieved through the reaction with approximately 9,400 gallons of oxidant injected.
- The highest benzene concentrations in soils were observed immediately adjacent to the Tank 1010 dike wall at depths ranging from 12 to 18 feet bgs.

Results from the pre- and post-injection monitoring event are included in the *Summary of Interim Measures Implemented at the Tank 1010 Site, Union Carbide Corporation, Institute, West Virginia* (CH2M 2016e).

Tank 1010 Area - Proposed Final Corrective Measure. The final proposed corrective measure for the Tank 1010 Area is a combination of Alternative 4 (Administrative and Institutional Controls) and Alternative 5 (Monitored Natural Attenuation). The combination of Alternative 4 and Alternative 5 was elected as the final measure based on the following factors:

- Excavation associated with Alternative 1 and Alternative 2 are not feasible based on the presence of the current infrastructure, specifically Tank 1010 and the associated dike wall. Performance monitoring results indicate that the highest remaining benzene concentrations in soil are located immediately adjacent to the dike wall and are presently inaccessible and technically impracticable to remove.
- Interim remediation was conducted for Alternative 3 and was found to have limited effectiveness in reducing source area soil concentrations due to site specific conditions. In situ treatment with other injected constituents is not anticipated to be effective based on these site specific conditions.
- Residual benzene mass in soil does not pose an unacceptable risk to the Kanawha River because the groundwater to pore water pathway is incomplete based on results from pore water sampling (CH2M 2013a).
- Alternative 4 will mitigate risk to facility workers.
- Alternative 4 and 5 will be implemented to monitor groundwater conditions to determine if reductions in plume size and concentration continue to occur and conditions remain protective of the Kanawha River.

Tank 1010 Area – Implementation, Performance Monitoring and Path Forward.

UCC will execute an EC for the facility to implement ICs to restrict access to subsurface soils and groundwater use in the Tank 1010 Area as described in Section 3.4 and Table 3-2. In addition, natural attenuation monitoring will be implemented in the Tank 1010 area to:

- Demonstrate that natural attenuation is occurring according to expectations;
- Detect changes in environmental conditions that may reduce the efficacy of the remedy;
- Verify that the plume is not expanding;
- Verify that there is no unacceptable impact to the Kanawha River; and
- Demonstrate the efficacy of the ICs.

Annual monitoring will be conducted in accordance with the approved sitewide PMP during the 4th quarter. Additional information regarding the monitoring approach will be provided in the CMIP.

If operating conditions at the facility change in the future and Tank 1010 is no longer utilized as part of an active chemical unit, then additional evaluation will be completed to determine if remediation remains technically impracticable or if remediation may be implemented to permanently remove or remediate benzene-impacted soils.

3.10.2.2 HPH Area

HPH Area Description and Background. High concentrations of benzene (approximately 20,000 μg/L) were detected in two monitoring wells adjacent to the Kanawha River in 2008, and an investigation was conducted upgradient of these wells in 2009 to determine the source. The source was identified in shallow unsaturated soil within the footprint of a former bulk storage area upgradient of the wells, where four 10,000-gallon ASTs (Tanks 1011 through 1014) once stood. The ASTs were reportedly used to store HPH fuel oil, process residue waste, and other constituents historically associated with the facility. The tanks were installed before 1950 and removed sometime between 2004 and 2008. The source area is currently referred to as the HPH Area and benzene is the main COC in the area soil and groundwater (Appendix A7 [presented on CD]; CH2M 2009b), although toluene, ethylbenzene, xylenes, and naphthalene are also detected.

HPH Area - Specific Remedial Action Objective. The RAO specific to the HPH Area is as follows:

- Remove contaminant mass from vadose zone and shallow groundwater such that dissolved concentrations in groundwater discharging to the Kanawha River do not exceed USEPA ecological screening levels.

The remedial operational goals for the HPH Area are noted as follows:

- Asymptotic trend in mass removal of extracted vapor; and
- Stable/decreasing constituent concentrations in the TW-63 well pair and continued low constituent concentrations in TW-68.

HPH Area - Interim Measures. A remedy evaluation was conducted in 2009, and AS/SVE was selected as the remedy for implementation. A copy of the *Technical Memorandum: Remedial Technology Comparison, High Purity Hydrocarbon (HPH) Area* (CH2M 2009b) is included in Appendix A7. As a result, an AS/SVE system was installed at the HPH Area between June 2010 and April 2011 (Appendix A8 [presented on CD]; CH2M 2012b).

Perched groundwater zones present within the target remediation area required that water be removed from SVE wells to dewater the zones and expose previously saturated soil to vapor to facilitate SVE operations. Soil fracturing (pneumatic and/or hydraulic) was also used to enhance secondary permeability within AS and SVE well boreholes. The remedial construction activities were completed between June 2010 and April 2011.

Five AS and eight SVE wells were installed, constructed of 2-inch-diameter polyvinyl chloride (PVC) components. AS wells were screened from 33 to 35 feet bgs and SVE wells were screened from 12 to 22 feet bgs. All wells were connected to their respective piping systems to accommodate system operation. A biofilter unit was initially utilized to treat the effluent air stream from the SVE system but was taken offline once confirmation samples determined that there were no permit exceedances or odor issues related to the discharge.

Two nested vacuum monitoring points were also installed at three locations, constructed of 1-inch-diameter PVC materials and screened at approximate depths of 11 to 13 feet bgs and 15.5 to 17.5 feet bgs at each location.

An approximately 2-foot-thick low-permeability clay cover was placed and compacted across the AS/SVE wellfield area and sloped to drain surface water to a stormwater drain located southwest of the AS/SVE wellfield. A vegetative cover was established on the clay cover to limit runoff volume. The system was activated in April 2011.

The RAOs and remedial operational goals for the HPH Area were met in 2014 and the system was shut down so that concentration rebound could be assessed (initial shutdown October 31, 2014). Rebound monitoring results indicated concentration rebound in the source area as well as in downgradient monitoring wells; as a result, the AS/SVE system was reactivated on August 6, 2015. System operations were switched to biosparge only (dewater and SVE components were deactivated) on December 11, 2015, with approval from USEPA (USEPA 2015c, Personal Communication). -

As of October 2015, when the SVE portion of the AS/SVE system was shut down, the AS/SVE system had removed a total estimated mass of 1,638 pounds of VOCs based on extracted vapor estimates (CH2M 2015g). This total does not include additional mass removed due to biodegradation while operating in biosparge mode (AS only). In addition, groundwater total VOC concentrations have been reduced in the source area by more than 99 percent.

HPH Area - Evaluation of Proposed Final Corrective Measures. As discussed previously, various remedial measures and technologies were evaluated and summarized in a 2009 document included in Appendix A7 (presented on CD) to this CMP entitled, *"Technical Memorandum: Remedial Technology Comparison, High Purity Hydrocarbon (HPH) Area"* (CH2M 2009b). The corrective measures evaluated were as follows:

- Alternative 1 - AS/SVE with Fracturing;
- Alternative 2 - In Situ Thermal Soil Treatment;
- Alternative 3 - Soil Mixing and Treatment;
- Alternative 4 - Excavation with Offsite Landfilling; and
- Alternative 5 - Excavation and Onsite Land Farming.

Advantages and limitations of each technology are presented in Appendix A7 (presented on CD).

HPH Area - Proposed Final Corrective Measure. The proposed final corrective measure is Alternative 1: continuation of the AS/SVE (the soil fracturing was already accomplished). Factors that contributed to its selection are described in detail in Appendix A7. Results from interim operations indicate that the AS/SVE operations have been very effective in removing constituent mass and reducing source area and downgradient groundwater concentrations. It is anticipated that the RAOs will be achieved and therefore, the AS/SVE system will continue to operate until the RAOs and the remedial operational goals are met as evidenced by field and operational data.

3.11 EU-7

EU-7, located in the northeast corner of the main chemical plant, is comprised of SWMUs 1, 7, 20, and AOC-2 as indicated on Figure 2-4. Current and future workers have the potential to encounter soil (surface and subsurface) and shallow groundwater (less than 12 feet bgs) through direct contact (Section 2.5 and Tables 2-2 and 2-3), and the HHRAs indicate that naphthalene is a COC in surface and subsurface soil, but that impacts are localized to the southwest corner of SWMU 7 (Table 3-2). Additionally, groundwater impacts (see Appendix B [presented on CD] and Section 2.5.2) comprise metals, VOCs, and SVOCs at concentrations greater than tap water RSLs, MCLs, and/or VISLs. Ratios of some maximum detected concentrations to applicable screening levels are greater than 100, which suggests potential risks greater than thresholds (i.e., an ELCR of 1 $x10^{-4}$ and an HI equal to 1; refer to Section 2.7.1) and that COCs may be present in groundwater as related to an unrestricted use scenario. As a result, ICs are required to mitigate potential future drinking water use and exposure to subsurface VOCs via the VI pathway. ICs planned for EU-7 comprise the following:

- Commercial/industrial land use across the EU;
- VI restriction for occupied structures across the EU;
- Groundwater use restriction across the EU;
- Restriction for moving excavated EU-7 soil to offsite locations until evaluation of soil condition and concentrations is completed.
- Surface and subsurface work restriction for SWMU 1 soil (Figure 3-1);
- Protection of CAs in place at SWMU 1; and
- Waste remains in place at SWMU 1 (a landfill).

Surface and subsurface soil concentrations exceed threshold criteria in the southwest corner of SWMU 7, requiring remedy evaluation due to the naphthalene concentrations present at depth (Figure 3-3 and Tables 2-2 and 3-2). The remainder of this section discusses site conditions associated with specific areas of EU-7, and the proposed final remedies for those areas.

3.11.1 SWMU 1

SWMU 1 is a former UCC landfill (part of site originally occupied by the TDI unit) that was used for disposal of oil, tarry materials, and possibly soluble hydrocarbons from a gas cracking unit that was used for rubber production in the 1940s and 1950s (CH2M 2010). The landfill is currently a 1-acre, gravel-covered, level area crossed by one rail line. A soil boring program completed in 2000 indicated the average depth of the former landfill is approximately 8.5 feet (CH2M 2003). Several “seeps” of a black, tar-like substance have historically surfaced in the road (G Street) south of the landfill, as well as in the gravel cover of the landfill. The material appears during periods of hot weather and results in the deposition of tar-like substances on the ground surface and analysis indicates it primarily consists of polycyclic aromatic hydrocarbons, including naphthalene (CH2M 2003), but samples do not contain constituents at levels that would cause it to be considered characteristically hazardous (CH2M 2005b). The material is also not a listed hazardous waste (CH2M 2015f).

Historical groundwater data (circa 2000 and 2008) from wells immediately north of SWMU 1 indicate concentrations of metals above screening criteria (CCR, CH2M 2009a; Appendix A, Table A-1 [presented on CD]). Groundwater conditions at all the SWMUs, AOCs, and CMS areas are being addressed via the sitewide groundwater monitoring program (CH2M 2015b).

3.11.1.1 SWMU-Specific Remedial Action Objectives

The goals of the CA specific to SWMU 1 were to:

- Minimize potential human contact with existing tar-like oozes; and
- Reduce the potential for future surface oozes.

3.11.1.2 Interim Corrective Measures

In 2003, approximately 80 tons of material were excavated and removed from the SWMU 1, including surficial tar-like oozes from both the eastern and western portions, and several areas on the asphalt roadway along the SWMU’s southern boundary. Concrete was installed within the roadway to replace excavated soils and topped with asphalt. The excavated areas outside of the roadway were backfilled with limestone base material and then covered with approximately 4 inches of gravel. The tar-like material also was removed from areas between the railroad tracks. However, the surrounding soil in these areas could not be removed. A September 2008 removal activity used an excavator to remove approximately 2 cubic yards of the tar-like material (CH2M 2010).

Access restrictions implemented in 2004 included installation of “Restricted Access Area” signs around perimeter of SMWU 1. Eight new signs were installed in 2016 to replace the aging signs. The following language appears on each new sign:

ATTENTION
RESTRICTED ACCESS AREA
(CONSTRUCTION, EXCAVATION, AND DRILLING RESTRICTED IN THIS AREA)
SOLID WASTE MANAGEMENT UNIT #1

> **Access to the area is restricted to those individuals that have written authorization and are performing maintenance or operational activities on the rail lines. Construction, excavation, and drilling are not permitted within this area (including G Street just south of the area) without written authorization. Contact the UCC Remediation Leader, Jerome Cibrik, at (304) 747-7788 to obtain written authorization.**

The site is inspected weekly and, when observed, tar-like substances are removed from the surface using a shovel. A more thorough removal is performed approximately once every 2 to 4 years. Clean gravel is used to backfill excavated areas.

3.11.1.3 SWMU 1 - Summary of Potential Exposures

A permeable cover is in place that prevents direct contact with waste materials; however, tarry seeps emerge during periods of high temperature, specifically around the existing rail spur. Toxicity characteristic leachate procedure (analysis of the tar material itself indicates that the material does not leach to the environment at levels that would cause the material to be defined as a hazardous material (CH2M 2005b). Access restrictions have been in place for SWMU 1 since 2004, limiting the individuals who can enter the SWMU 1 boundary or perform O&M on the rail lines. Construction, excavation, and drilling are not allowed without specific administrative knowledge. Periodic checks for tar seeps are performed by personnel who do not directly contact the material, who wear appropriate personal protective equipment, and who are performing observation in accordance with an appropriate Health and Safety Plan (HASP). Required intrusive activities require an activity-specific HASP and the use of appropriately trained personnel.

Groundwater concentrations from wells included in the PMP that are located in along the SWMU 1 boundaries exceed VISLs and drinking water screening levels, but groundwater is being addressed on a sitewide basis in accordance with the approved PMP (CH2M 2015b).

3.11.1.4 SWMU 1 - Evaluation of Proposed Final Corrective Measures

Corrective measures were evaluated for SWMU 1 and described in the *Corrective Measures Evaluation for Solid Waste Management Unit* 1 Report submitted to USEPA in August 2003 (CH2M 2003). The measures evaluated are briefly summarized as follows:

- Alternative 1 – Institutional Controls - Placement of signs at the site and administrative requirements for intrusive activities and contractors to address potential future contact with impacted soil or waste material.
- Alternative 2 – Focused Removal with Institutional Controls as per Alternative 1; spot-excavation and removal and/or covering of existing tar-like substances with offsite disposal at an approved waste disposal facility; backfilling with clean material; installation of permanent fencing; and long-term, periodic monitoring and removal of oozes if encountered.

- Alternative 3 – Waste Removal and Offsite Disposal of the landfilled materials; removal of existing railroad spurs and drainage structures; excavation of tar-like substances identified in the area (assumed 8.5 feet of materials excavated and removed) with offsite disposal at an approved waste disposal facility; backfill with clean material; and replacement of drainage structures and rail spurs.
- Alternative 4 –Placement of a Continuous Geomembrane-Based Cover System Over the Entire Area; grading and surface preparation to include removal and offsite disposal of some impacted material; installation of a 6-inch compacted soil bedding layer over the graded surface, a 60-millimeter high-density polyethylene geomembrane over the entire site, a 16-ounce protective layer over the geomembrane, and 12 to 24 inches of gravel as a cover layer.
- Alternative 5 –Geomembrane Barrier with Gravel Surfacing, Periodic Monitoring and Institutional Controls; placement of the geomembrane with gravel surfacing over the non-rail areas of the site only (no rail track removal); institutional and administrative restrictions along with periodic inspection and removal of oozes as per Alternative 2.

The recommended alternative as per the 2003 report was Alternative 2 based on its reasonable conformance with the RAOs, its relative cost effectiveness, and the relatively short period required for implementation. Alternative 2 was implemented starting in 2003 with removal of the surficial tarry material and in 2004 with construction and posting of the warning signs; additional material was removed in 2008 (CH2M 2005b, 2010).

3.11.1.5 SWMU 1 - Proposed Final Corrective Measures

The proposed final corrective measure for SWMU 1 is Alternative 2. The interim actions have been demonstrated to be effective as an interim measure and will remain effective in the long term. Alternative 2 is also the most cost-effective alternative to maintain in the future. Further efforts will be made to limit exposure by improving the gravel cover, adding permanent fencing around the extent of the SWMU that will include access gates for active rail, and adding improved signage.

Weekly inspection and periodic removal of the tar-like substance will continue after track removal. If lesser amounts are encountered at a reduced frequency, a proposal will be made to reduce the regularity of inspections in this area.

3.11.2 SWMUs 7 and 20

SWMU 7 encompasses the former SEVIN® Unit and NCF areas. SEVIN® insecticide was produced in the SEVIN® Unit, which began operation in 1960. The unit was demolished in December 2013 (CH2M 2015e). In 2000, SWMU 7 was expanded to include the NCF Tank Farm area, which was also demolished in December 2013.

SWMU 20, “the Southside Loading Rack,” is immediately south of SWMU 7 and was a 20-foot by 40-foot asphalt-covered concrete transfer station for tank trucks. The rack and other associated equipment were also demolished in December 2013 and the area currently is covered by gravel.

SWMUs 7 and 20 are adjoining areas and were combined for remedy evaluation. These SWMUs were two of six SWMUs within the facility originally designated as a high priority for investigation and potential remediation. Toluene, believed to be associated with leaks from refined toluene storage tanks, was the main COC. Chlorobenzene, benzene, and chloroform contamination was also found in the area and likely originated from inactive production units located north and west of the SEVIN® Unit, not associated with SWMU 7 itself. Elevated naphthalene concentrations in surface and subsurface soil samples collected in the southwest corner of SWMU 7 (Figure 3-3) drove the non-cancer HI for EU-7 to an HI of 2, greater than the threshold of 1.

Groundwater conditions at all the SWMUs, AOCs, and CMS areas being addressed via the sitewide groundwater monitoring program.

3.11.2.1 SWMU-Specific Remedial Action Objectives

There have been no SWMU-specific RAOs established; however, the sitewide RAOs apply.

3.11.2.2 SWMUs 7 and 20 - Interim Corrective Measures

Corrective measures consisting of an AS/SVE system were implemented in 1997 at the SEVIN® area and were expanded in 2000 to include the NCF area within SWMU 7. Operation of the remediation system at the SEVIN®Unit area resulted in nearly complete removal of toluene (a reduction of more than 99 percent) from the site groundwater by the year 2000, and remediation at SWMU 7 (SEVIN® and NCF) areas was completed in 2002 (Key Environmental and CH2M 2006).

3.11.2.3 SWMUs 7 and 20 - Proposed Final Corrective Measures

The interim CA previously described has been implemented and completed (Key Environmental and CH2M 2006). The final corrective measure will consist of those ICs associated with EU-7 (Section 3.11) as well as removal of a hotspot in the southwest corner of SWMU 7 where naphthalene concentrations in surface and subsurface soil are driving non-cancer HIs above the threshold of 1 for EU-7 (Figure 3-3).

The hotspot removal will be implemented as detailed in the CMIP but the general steps to be followed include:

1. Surface soils will be removed inclusive of all areas that exceed a naphthalene concentration of 590 mg/kg (based on the industrial soil RSL [USEPA 2015a] assuming a minimum target risk level of $1x10^{-4}$ and target HQ of 1) and disposed of at an appropriate offsite facility.
2. Sampling of the base of the excavation will be completed following the removal action to determine if subsurface soils remain above the applicable risk threshold. If naphthalene concentrations in samples collected from the base of the excavation do not meet the 590 mg/kg criterion, a future subsurface work restriction may need to be established for this area of SWMU 7.

Once the removal action is complete, the concentrations of naphthalene should be below risk thresholds for SWMU 7 and EU-7. The sampling results, delineation efforts, and resultant excavation measure will be documented in a construction completion report.

3.11.3 AOC-2

AOC-2 consists of a former naphthalene tank (Tank 1252) that was demolished in 1995. Staining was observed and solidified naphthalene was present in the gravel within the concrete tank rings during demolition activities (UCC 2001). Secondary containment dikes were pushed in and the ground surface leveled across this area. Naphthalene detected in soil was present at levels below the industrial soil screening levels.

Groundwater grab sampling conducted in 2002 revealed elevated levels of arsenic and naphthalene at a location directly downgradient of AOC-2 (Kemron 2003). Monitoring well MW-104 was later installed to assess this concern (CH2M 2009a). Since that time, naphthalene has been detected in groundwater samples collected from this monitoring well at concentrations exceeding screening levels. AOC-2 is currently an open area.

3.11.3.1 AOC-Specific Remedial Action Objectives

There have been no AOC-specific RAOs established; however, the sitewide RAOs apply.

3.11.3.2 AOC-2 Interim Corrective Measures

The former naphthalene tank was demolished and approximately 290 cubic yards of soil and gravel were excavated and removed in 1995.

3.11.3.3 AOC-2 - Proposed Final Corrective Measures

With the exception of groundwater impacts related to unrestricted use, which are addressed on a sitewide basis, risk estimates for potential worker exposures are below thresholds; therefore, final corrective measures specific to AOC-2 are not required.

3.12 EU-8

EU-8, located in the southeast corner of the main chemical plant, is comprised of SWMUs 13 and 15 as indicated on Figure 2-4. Current and future workers have the potential to encounter soil (surface and subsurface) and shallow groundwater (less than 12 feet bgs) through direct contact (Section 2.5 and Tables 2-2 and 2-3), and the HHRAs indicate that lead concentrations found in one of 29 subsurface samples just outside of the northeast corner of SWMU 13 exceed the USEPA RSL for lead in Industrial Soil. A subsurface work restriction is required to mitigate potential exposures to lead concentrations in SWMU 13 subsurface soil. Restrictions are not required for workers potentially exposed to shallow groundwater during subsurface work activities; however, groundwater impacts (see Appendix B [presented on CD] and Section 2.5.2) comprise metals, VOCs, and SVOCs at concentrations greater than tap water RSLs, MCLs, and/or VISLs. Ratios of some maximum detected concentrations to applicable screening levels are greater than 100, which suggests potential risks greater than thresholds (i.e., an ELCR of 1×10^{-4} and an HI equal to 1; refer to Section 2.7.1) and that COCs are present in groundwater as related to an unrestricted use scenario. As a result, restrictions are required to mitigate potential future drinking water use and exposure to subsurface VOCs via the VI pathway.

The following ICs are planned for EU-8:

- Commercial/industrial land use across the EU;
- VI restriction for occupied structures across the EU;
- Groundwater use restriction across the EU;
- Restriction for moving excavated EU-8 soil to offsite locations until evaluation of soil condition and concentrations is completed; and
- Subsurface work restriction for SWMU 13.

The remainder of this section discusses site conditions associated with SWMU 13 and 15, and proposed final remedies for each.

3.12.1 SWMU 13

This unit consisted of a 10,000-gallon stainless steel hydroxyethyl cellulose storage tank located adjacent to former Building 87. The tank rested on a concrete foundation and was surrounded by a concrete dike. Building 86 adjacent to Building 87 also required waste recovery operations (UCC 2001). The unit, foundation, pavement, dike, and Building 87 were removed, and operations in Building 86 were discontinued. The former SWMU 13 area is covered with gravel and concrete.

Investigation activities at SWMU 13 in 1992, 2000, and 2002 determined minimal metals impacts occur in subsurface soils (beryllium, silver, barium, and nickel) and no impacts to groundwater (REMCOR 1992; UCC 2000; Kemron 2003).

Although the CCR (CH2M 2009a) recommendation was that no further investigation was required at SWMU 13, all available groundwater and soil data were reviewed for the most recent HHRA to assess if additional investigation was warranted (CH2M 2016a). Elevated lead concentrations in subsurface soil samples collected in the northeast corner of SWMU 13 exceed the USEPA RSL for Industrial Soil of 800 mg/kg (November 2015; http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm).

3.12.1.1 SWMU-Specific Remedial Action Objectives

There have been no SWMU-specific RAOs established; however, the sitewide RAOs apply.

3.12.1.2 SWMU 13 Interim Corrective Measures

There have been no interim corrective measures implemented at SWMU 13.

3.12.1.3 SWMU 13 - Proposed Final Corrective Measure

The final corrective measure will consist of those actions associated with EU-8 (Section 3.12) and a subsurface work restriction for SWMU 13 due to lead concentrations in subsurface soil that exceed the Industrial Soil RSL for lead (Section 2.7.1).

3.12.2 SWMU 15

SWMU 15 is comprised of the "Eastside Tank Car/Truck Cleaning Rack" that is currently in service.

Historically, solvent materials were primarily manufactured and shipped in the area served by the eastside rack. The tank car cleaning area consists of four parallel sections of track through a gravel-covered area. Water is captured by metal-grated, concrete channels where a sump sends water to the process sewer. Tank truck cleaning is performed on an asphalt pad immediately west of the railroad tracks.

Sampling and investigation activities occurred in this area between 2000 and 2012. Although the CCR (CH2M 2009a) recommendation was that no further investigation was required at SWMU 15, all available acetone groundwater and soil data were reviewed in 2015 to re-assess the nature and extent of acetone impacts (see Appendix A3 [presented on CD]; CH2M 2015d). Elevated groundwater concentrations of acetone were identified as being confined to the perched and shallow aquifer zones. Impacts did not migrate downgradient and have decreased significantly over time (CH2M 2015d). Acetone is present in the shallow and perched groundwater at concentrations greater than USEPA's tap water RSL; however, acetone concentrations do not exceed the VISL at any depth, and detected soil sample concentrations do not exceed the industrial soil RSL. These RSL comparisons indicate that potential exposure would result in risks below thresholds for the VI and direct contact soil pathways and groundwater conditions with respect to tap water use are being addressed at all the SWMUs, AOCs, and CMS areas via the sitewide groundwater monitoring program.

The results of the 2015 data evaluation (VISLs and industrial soil RSLs not exceeded), and the fact that groundwater conditions are addressed via the ongoing sitewide program, suggest that additional investigation in this area is not warranted (CH2M 2015d).

3.12.2.1 SWMU-Specific Remedial Action Objectives

There have been no SWMU-specific RAOs established; however, the sitewide RAOs apply.

3.12.2.2 SWMU 15 Interim Corrective Measures

There have been no interim corrective measures implemented at SWMU 15.

3.12.2.3 SWMU 15 - Proposed Final Corrective Measure

Risks associated with potential worker exposures in SWMU 15 are below thresholds. Groundwater exposures as related to an unrestricted use scenario (e.g., residential tap water use) will be addressed on a sitewide basis; therefore, the final corrective measure at SWMU 15 will consist of those actions associated with EU-8 (e.g., restriction to industrial/commercial use, evaluation of excavated soil to be moved offsite, groundwater use restrictions, and VI restrictions for occupied structures).

3.13 Offsite Properties

3.13.1 Appalachian Power Company

Site assessment activities determined that groundwater flows from the western boundary of the area of the main chemical plant toward the APCO parcel, and the groundwater contains 1,4-dioxane from historical operations at the UCC property at levels that exceed USEPA'S tap water RSL (Figure 2-2). Therefore, groundwater grab samples were collected from the APCO parcel in July 2011 and analyzed for 1,4-dioxane. 1,4-Dioxane in several of the groundwater samples exceeded USEPA'S tap water RSL (CH2M 2011c). All detected concentrations of 1,4-dioxane in groundwater beneath the APCO parcel were below a calculated ecological screening value and, as a result, 1,4-dioxane in groundwater that may be flowing beneath APCO and into the adjacent Kanawha River is not expected to pose ecological risk concerns for ecological receptors (CH2M 2011c).

The proposed CA consists of restricting groundwater use on the APCO property. The restriction will be implemented by recording an EC prohibiting the use of groundwater in areas that may be affected. The EC, once recorded, will prohibit extraction of groundwater from the APCO property for any purpose other than monitoring, remediation, or to support electrical substation construction as approved by WVDEP. UCC is working with APCO to obtain an EC.

3.13.2 West Virginia State University

Groundwater generally flows to the south-southwest at the facility toward the Kanawha River; however, along the facility's eastern property boundary there is a slight southeastern gradient towards the WVSU property (Figure 2-2). Once at the WVSU property, the flow direction deflects back toward the Kanawha River. Groundwater impacts above applicable USEPA MCLs and/or RSLs on the WVSU property are documented in a report submitted to USEPA (CH2M 2016f) and appear to have resulted from more than one source. Groundwater flow patterns and constituents of potential concern (COPCs) concentrations suggest that 1,4-dioxane, chloroform and 1,1-DCA have migrated from the Institute facility onto the southwestern portion of the WVSU property before migrating towards the Kanawha River. USEPA approved the report in correspondence dated July 18, 2016.

Groundwater data indicate that the VI pathway relative to impacts from the Institute facility is incomplete with the exception of potential future residential-type use (e.g., homes, dormitories, daycare, or other) for the southwestern portion of WVSU property. As proposed (CH2M 2013c) and approved by USEPA in April 2014, potential risks from groundwater will be addressed by filing an EC that prohibits the construction of occupied structures over areas of identified VI risk unless a VI mitigation system is installed, and the EC restricts groundwater usage to remediation and monitoring only. UCC is working with WVSU to obtain an EC.

3.13.3 Norfolk Southern (NS) Railway

There are no groundwater sampling results specifically collected from samples at the NS property, which traverses the length of the main chemical plant and WWTU east-to-west. However, groundwater samples collected from the areas north and south of the NS track that runs through the main chemical plant and WWTU report VOCs, SVOCs, and metals at concentrations greater than MCLs, tap water RSLs, and/or VISLs. Therefore, potential risks from groundwater at the stated portion of NS property should be addressed by filing an EC that prohibits the construction of occupied structures over this area unless a VI mitigation system is installed. The EC would also restrict groundwater usage to remediation and monitoring only. UCC is working with NS to obtain an EC.

4 Schedule

Figure 4-1 shows a general schedule that includes preparation and finalization of the Statement of Basis, and a WVDEP Corrective Action Permit, preparation of the CMIP, and preparation of EC documents. The CMIP will include a schedule for CMIP implementation.

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Tables

Figures

Appendix A
Area-Specific Reports (Presented on CD)

- Appendix A1 Institute 2008, 2009 Sevin Unit [SWMU 7], SWMU 1, and SWMUs 2-6 Corrective Measures Completion Report
- Appendix A2 Waste in Place Current Conditions Report SWMU 1 and SWMU 5
- Appendix A3 Technical Memorandum: Acetone Area Summary
- Appendix A4 SWMU 19 Current Conditions Report
- Appendix A5 Final Tank 1010 Source Area Investigation
- Appendix A6 Tank 1010 Area Remedial Approach Report
- Appendix A7 Technical Memorandum: Remedial Technology Comparison, Screening Area 6 (HPH)
- Appendix A8 Construction Completion Report. Former High-Purity Hydrocarbon Storage Area Remedial Construction
- Appendix A9 Construction Completion Report, SWMU 11 Cover Improvement

Appendix B
Groundwater Summary Statistics
(Presented on CD)